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ABSTRACT

This manual is designed for use in a 1-year, grade 11 forestry course. The manual consists of eight units that focus on: (1) dendrology (tree description); (2) forestry measurements; (3) maps and aerial photography; (4) Canadian forest geography; (5) logging and utilization; (6) forest management and silviculture (the science and art of cultivating forest crops); (7) forest protection (considering fire, insect, and disease protection); and (8) wildlife management. Each unit contains objectives, background information, instructional strategies, student activities, and (when applicable) student materials. Suggested equipment requirements, a list of audiovisual aids, and the addresses of organizations, colleges/universities, and federal government agencies are included in appendices. (JN)

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A FORESTRY MANUAL FOR ONTARIO SECONDARY SCHOOL TEACHERS

G.R. MORRISON

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A FORESTRY MANUAL FOR ONTARIO SECONDARY SCHOOL TEACHERS

G.R. MORRISON

ONTARIO FORESTRY ASSOCIATION
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FOREWORD

George Morrison was a practicing forester for many years. During that time he was active in education activities such as the Forestry Correspondence Course of the Department of Veterans Affairs and the Espanola Conservation Course run annually for grade VIII students. He then entered a career as a teacher at Espanola High School and was soon teaching a forestry course for grade X's. In both occupations Mr. Morrison was generous in sharing his knowledge of forestry and in encouraging interest in it by others. Last year he retired from teaching.

When Mr. Morrison suggested publishing his teaching notes as a guideline for others the Ontario Forestry Association agreed to do so. It was felt that more forestry materials for school use are needed and the notes offered a tremendous amount of useful information already tested in a school program. The views expressed are those of Mr. Morrison, not necessarily the OFA, of course, but they cover a wide range of forestry concerns worth exploring. Some may wish for more on the effects of acid rain or the current state of our forests but a framework is here upon which such discussions could ensue.

There have been some minor amendments to the original notes to permit printing in this format. The changes are few, however, and the result is basically the same as Mr. Morrison's original notes.

Special mention should be made of the work of Alyce Tweedley and Dan Milligan who produced the type and drawings as you see them. Those from other sources deserve credit, too, for they represent a major contribution to forestry education by the agencies responsible for them. We appreciate being able to use them.

Your comments and suggestions for improving upon individual activities, whole units or the whole manual will be appreciated. More discussion of forestry is wanted and your views will be welcomed.

Willowdale,
Ontario
September, 1983

J. D. Coats, RPF,
Executive Vice President
Ontario Forestry Association

AUTHOR'S COMMENTS

What is forestry? Forestry is the science of managing forest resources. What is involved? Forestry deals with many things – reforestation, logging, protection, wildlife and recreation.

This course is designed to give a general view of forestry – a 'once over lightly' approach. It should be remembered that university and college forestry courses take two, three and four years so this course does not attempt to be an in-depth study.

Why should one study forestry? Increasingly forestry is being recognized as a very basic part of our economy and lifestyle. Our forest resources will be better managed if the public understands the fundamental principles involved. Some may develop an interest in forestry as a career. For others a greater appreciation of the outdoors will add to the enjoyment they get from their natural surroundings.

Espanola, Ontario
September, 1983

George R. Morrison, RPF,
Teacher, Espanola High School (retired)

INTRODUCTION

This one year forestry course is designed for grade 11 students in Ontario secondary schools. Given suitable adjustments it can be used at advanced, general or open levels. The one year course is based upon 110 hours of teaching time.

The Ministry of Education has accepted forestry as a credit course under the Intermediate and Senior Environmental Science Guideline.

This manual is also a guideline. It can be modified, adjusted and up-dated in line with circumstances. Some of the changes may include the following:

- A school in southern Ontario may want to include the identification of a number of tree species not now covered in the manual.
- Forestry measurements and calculations are made using a mixture of some of the imperial units still in use in forestry and metric which is emphasized. It may soon be desirable to use only metric.
- Individual teachers may want to change the emphasis in certain sections because of their own interests and/or backgrounds or due to local priorities. (The view of forestry for students in a pulp and paper town like Espanola may be different than that of Toronto students.)
- It may well be found that the coverage given wildlife management is too brief or that scaling is studied in too much detail.

Students may find that there is too much writing, too many notes. This complaint is not without justification. Teachers can ease this problem by copying the instruction sheets included here for members of the class.

The program includes the following:

- **Classroom instruction** and activities
- **Outdoor classes** – there are several possibilities for these.
- **Field trips** – there should be at least two and more would be better.
- **Audio visual presentations** – films, film strips, etc. are suggested.
- **Activities** – a great many projects and activities are proposed.
- **Guest speakers** – specialists are recommended for a change of pace and added interest.

The forestry course described in this manual is based on a number of years of classroom experience. It has been successful in providing an interesting program and most of the students who complete the year do so with a much better understanding of what forestry is all about.

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UNIT 1
DENDROLOGY
(tree description)

UNIT 1: DENDROLOGY (tree description)

OBJECTIVE

Students should be able to identify the most common tree species.

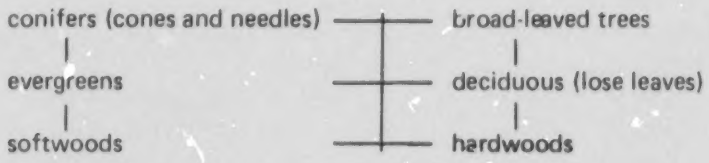
(In parts of Ontario more and different trees may be studied than suggested here. Identification on the basis of leaves is emphasized.)

1.1 BASIC TREE CLASSIFICATIONS

Trees may be named in groups or as individuals and in a variety of ways of which the following are most common:

a) Conifers and deciduous

These two major groups of trees are also known by other names:



There are exceptions to the interchangeability of these names in each column:

i) There are soft hardwoods (eg. poplar and balsa) and hard softwoods (eg. jack pine and red pine)

ii) Tamarack (larch) is a conifer that is not evergreen. It loses all its needles in the fall.

iii) Evergreens do lose their needles, mostly in the fall, but the younger needles at the ends of the branches remain through two or more growing seasons.

b) Tolerant and intolerant

Tolerant refers to the ability of the tree to compete on a particular site in relation to various factors of which light is a major one.

Tolerant trees - grow well in the shade (eg. maples and balsam)

Intolerant trees - are intolerant of shade and require lots of sunlight. They grow best in open areas. (eg. red pine, jack pine and poplar)

ACTIVITY

It may be interesting at this point to list on the board as many tree species as the students can name.

An Introductory Look At The Text

NATIVE TREES OF CANADA is available in most book stores.

Note the maps on the inside covers which show the Forest Regions of Canada. (Some may have studied these regions in geography courses.)

Scan tree terminology (pages 27–31)

Note the detailed coverage given to each species (eg. white pine, p. 36; white birch, p. 160)

Peruse the appendices (p. 321 plus)

c) Common (or local) Tree Names vs Botanical Names

Read "How Trees Are Named" (text p. 23)

What are the weaknesses in using common names?

- different names for same tree
- not international
- may change with time

What are the advantages of using botanical (Latin) names?

Though common names will be used here and Latin names left for more advanced studies the students should understand how the system works and be able to explain an example.

Example 1

Pinus strobus L. (white pine, p. 36 in text)

Pinus - generic name (genus) - - - with a capital (p. 340)
strobus - specific name (species) - - - small letter (p. 341)
L. - the botanical author, honoured in this way – L for Linnaeus (p. 329)

Example 2 (more complicated)

Betula papyrifera Marsh. var. commutata (Reg.) – white birch. Read page 24 in the text for origins of this botanical name.

1.2 TREE IDENTIFICATION FEATURES

Trees may be identified by using one or more of the following features:

a) Leaves or needles
b) Twigs - opposite or alternate branching
- most trees have alternate
- a few have opposite (eg. ashes, maples)
c) Buds - arrangement, scales, colour
d) Cones or fruit
e) Bark - smooth or flaky, ridged, colour, etc.
f) Form - the overall shape of the tree (eg. balsam is spire-shaped -- elm is fan- or umbrella-shaped)
g) Smell - sometimes distinctive (eg. cedar)

TEACHING AIDS

Tree identification slides and a coniferous tree identification wheel are available from the Ontario Forestry Association.

Film strips, posters and tree identification books are available from other sources such as libraries, stores and governments.

1.3 A LEAF COLLECTION

Distribute the leaf collection instruction sheet (page 15.)

Discuss the details.

Point out that information on tree identification will be studied in upcoming classes.

1.4 LEAF AND TWIG TERMS

Refer to NATIVE TREES OF CANADA, pages 28 & 29.

Distribute the instruction sheet on Leaves and Twigs (page 16 of this manual.)

Discuss the diagrams and terms.

1.5 FIELD TRIPS

There should be one or more field trips of an hour, half a day or one full day to areas where students will have an opportunity to practice tree identification. This should be timed to give the students an opportunity to complete their leaf collections while leaves are on the trees. It should come after sufficient classroom instruction has been given to make the outing meaningful.

Prior To Going Out

Prior to going out it will be necessary to advise the students regarding reports, smoke breaks, keeping together, collecting leaves, note-keeping, safety, appropriate dress, etc.

Arrangements must be made for a bus, other supervisors, supply teacher to cover in-school commitments, attendance checks, loud hailers, postponement arrangements, lunch stops, washrooms, sickness and similar matters.

Instruction Sheets 3 and 4

A simple outing in the area of the school can provide an opportunity to get students thinking and observing tree details. Instruction sheet 4 on page 19 provides a sample Tree Description Report which student could complete on such an outing.

Instruction Sheet 3, pages 17 and 18, is a sample Field Trip Report developed for a major outing to a specific area. It may give you some ideas for similar reporting.

It is suggested that report sheets be distributed in class for review purposes, collected and re-distributed again at the start of a field trip. Reports may be collected at the end of the field trip and results compared.

1.6 IDENTIFYING CONIFEROUS TREES

Emphasis to this point has been on tree classifications and features by which trees can be identified. In this section some of the best identification features of conifers are recorded.

All pines have their needles in clusters (groups) of 2 or more. The only other conifer with clusters of needles is **tamarack**.

Use available samples of the foliage and NATIVE TREES OF CANADA (to which page numbers shown below refer.)

a) PINES

White pine (p. 36)
- only pine with 5 needles/cluster
- gray bark, smooth when young, ridged when older

Red pine (p. 48)
- 2 long needles/cluster
- reddish, flaky bark.

Jack pine (p. 50)
- 2 short needles/cluster, they tend to spread in a "V". Dark gray bark.

Scots pine
- not native to Canada, is an introduced or "exotic" species
- somewhat like jack pine with 2 needles/cluster but when the needle pair is brought together between the fingers the needles show a twist or spiral
- distinctive yellow orange bark

b) SPRUCE, BALSAM, HEMLOCK

With these three species the needles grow separately, not in clusters, on the stem. Identification between the three is not difficult. There are three spruce species in Ontario (black, white and red) but separation by the foliage only is difficult and not required here.

Spruce (p. 64)
- 4-sided, short needles (roll between fingers like a wooden match)
- needles stick out all around twig
- twigs rough when needles brushed off as needle bases stick out from stem

Balsam (p. 88)
- also known as balsam fir or fir
- 2-sided needles (flat)
- needles on 2 sides of twig
- often 2 silvery lines on underside of needle, shiny green above
- twigs smooth when needles off
- bark has gum blisters

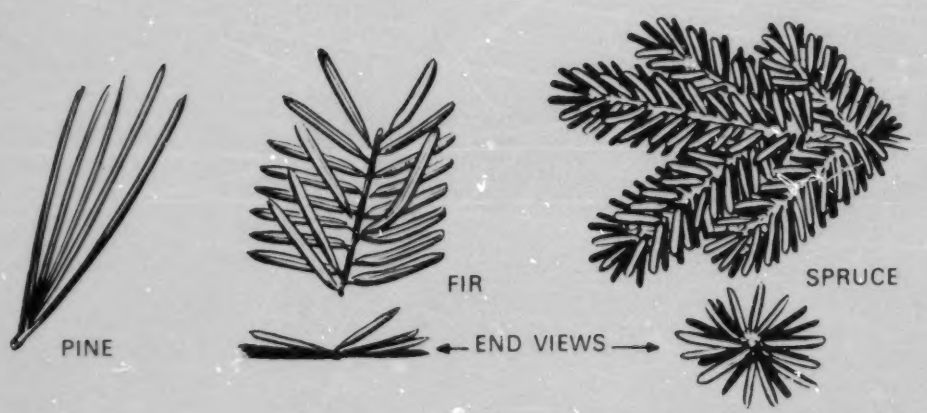
Hemlock (p. 76)
- 2-sided needles (flat)
- needles attached to twig by short stalk
- undersurface silvery, top dark green
- twigs rough when needles fall
- tree crown has feathery look

c) TAMARACK

Tamarack (p. 56)
- also called "larch"
- has needles singly and in clusters
  most needles are in clusters of up to 30 or more per cluster
- foliage tends to be light green in summer, yellow in autumn
- loses all its needles in the fall
- is our only deciduous conifer and our only conifer that is not "evergreen"

d) CEDAR

Cedar (p. 98)
- flat, scale-like leaves instead of needles
- scales overlap, cover the twig
- distinctive cedar colour



1.7 IDENTIFYING DECIDUOUS TREES

As in the preceding section only the main identification features are provided. This enables identification of the major trees without going through all the detail provided in NATIVE TREES OF CANADA (to which the page numbers refer).

Students could be asked to draw the leaves to show the main identification features.

Sample leaves might be brought to class to review and reinforce the details.

Deciduous trees are divided into two main groups

1) Trees with **opposite** branching (maples and ashes)
2) Trees with **alternate** branching (most others)

a) MAPLES (Opposite Branching)

Sugar (hard) maple (p. 264)	- simple leaf, 5 lobes - lobes nearly square - few wavy teeth on margin
Silver (soft) maple (p. 272)	- simple leaf, 5 lobed - deep, 'U' shaped notches - sharp, doubly toothed margin - smooth, silvery undersurface
Red (soft) maple (p. 274)	- simple leaf, 3-5 lobes - doubly toothed - sides of end lobe nearly parallel to midrib - notches at almost 90 degree angle - red leaf stem often brilliant scarlet in fall
Manitoba maple (p. 284)	- compound leaf (only maple with this) - 3-7 leaflets having shallow lobes - irregular-shaped leaf
Mountain and striped maples (p. 276, 278)	- students should be aware of them but not of major importance here

b) ASHES (Opposite Branching)

White ash (p. 304)	- compound leaf, oval shape - usually seven leaflets - leaflets stalked - smooth margins (no teeth)

Black ash (p. 310)
- compound leaf, oval shape
- 7-11 leaflets
- no stalks on leaflets
- finely, sharply toothed margin
- found in wet areas

A Comparison

Manitoba maple **White ash**

Similarities
compound leaves
opposite branching

Differences

3-7 leaflets	usually 7 leaflets
variable shape & size	oval shape
shallow lobes on leaflets	no lobes

c) BIRCHES (Alternate Branching, Simple Leaves)

White birch (p. 160)
- leaf triangular to egg shaped
- few prominent veins
- no teeth at base
- single-toothed
- smooth reddish bark when young, white and can be peeled off in sheets when older (please don't)

Yellow birch (p. 156)
- oval leaf, pointed tip
- many veins
- double-toothed all around margin
- bark dark red and shiny when young, yellowish or bronze with curls of bark when older

d) POPLARS (Alternate Branching, Simple Leaves)

Included under this heading are cottonwoods, poplars and aspens.

Bark on young trees is whitish- or yellowish-green and smooth. It turns grayish to brown when older and is generally furrowed.

Most are fast growing and short-lived.

They **reproduce** mainly by "sucker growth" from their roots or stumps. (Vegetative reproduction.) Each tree has either male or female flowers, not both.

Trembling aspen (p. 120)	- leaves circular; short, sharp tip - finely rounded teeth on margin - stem as long or longer than blade - "trembles" in breeze due to flat stem
Largetooth aspen (p. 122)	- larger leaf than trembling aspen - distinctively coarse, single toothed margin
Balsam poplar (p. 124)	- egg-shaped leaf tapers to sharp tip - finely toothed margin - shiny dark green above, blotchy brown below - round stalk - older bark dark, ridged - distinctive odour - also called (incorrectly) Balm of Gilead
Silver poplar (p. 118)	- introduced species - leaves "maple" shaped - alternate branching - white, woolly hairs on undersurface
Lombardy poplar (p. 118)	- an introduced species - spire-like crown, branches point upwards - triangular leaves
Carolina poplar (p. 118)	- triangular leaves - flat leaf stem - branches tend to rise at 45° from main trunk - introduced species - similar in appearance to eastern cottonwood

e) ELMS (Alternate Branching, Simple Leaves)

White elm (p. 200)	- leaves oval, double-toothed margin - prominent straight veins, rarely forked - top surface smooth to "sand papery" - tree is fan shaped (to umbrella-shaped) - severely affected by Dutch elm disease

f) OAKS (Alternate Branching, Simple Leaves, Fruit Is An Acorn)

White oak (p. 182)	- 7 to 9 lobes - deep notches, rounded lobes - large, blunt teeth - buds clustered at end of twig - bark gray and scaly

Red oak (p. 192)
- 7-9 lobes
- large, pointed teeth
- V-shaped notches
- bark has smooth ridges

Bur oak (p. 186)
- variable shape, broadest towards tip
- large terminal lobe
- lobes rounded
- hairy undersurface

g) WILLOWS (Alternate Branching, Simple Leaves)

There are several species of willow. All have long, narrow leaves, pointed at the ends, with short stalk. Trees have either male or female flowers, not both.

Weeping willows
- introduced species
- slender drooping branches

Black willow (p. 116)
- leaves green on upper and lower surfaces
- finely-toothed
- the most common willow

Pussy willow (p. 116)
- leaves sometimes broader at middle or towards tip
- whitish underneath
- maybe a few rounded teeth on margin
- usually grows as a bush

h) CHERRY (Alternate Branching, Simple Leaves)

Black cherry is of commercial importance. The two which follow are not but are common throughout most of Ontario

Choke cherry (p. 242)
- broadly oval, abrupt short tip
- broadest towards tip
- finely sharp-toothed, thin leaf

Pin cherry (p. 244)
- lance-shaped leaves
- tapering point often curves to side
- very thin, green undersurface
- small, irregular teeth; two sizes alternating

i) BEECH (Alternate Branching, Simple Leaves)

Beech (p. 176)
- leaves are elongated oval
- prominently single-toothed
- prominent vein ending in each tooth
- bark distinctively bluish gray

j) BASSWOOD (Alternate Branching, Simple Leaves)

Basswood (p. 288)
- large, heart-shaped leaf with one side lower than other (lopsided)
- single-toothed
- distinctive fruit attached to leaf-like structure

k) SHRUBS

There are many shrubs in Ontario. A few are encountered often and should be known because they occupy land in many forest areas.

Alder (p. 172)
- leaves thick, dull, wrinkled above and hairy below
- prominent straight veins, impressed above and projecting below
- smooth bark, lenticels (like cherry)
- fruit a woody catkin like a small cone

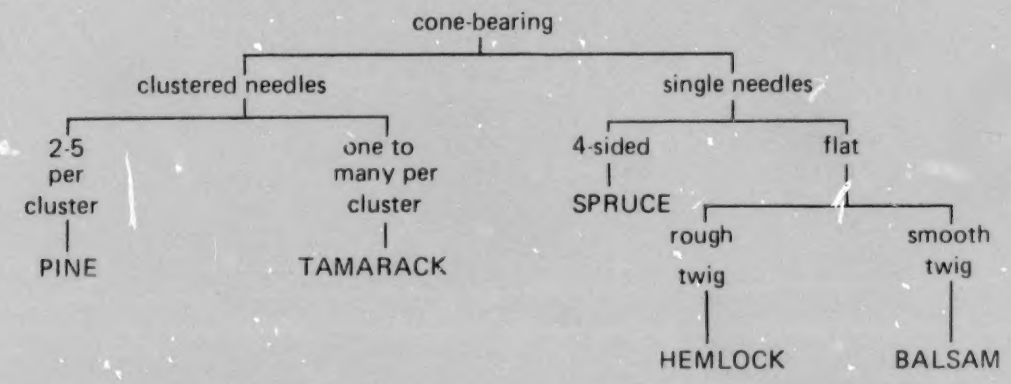
Hazel (Beaked hazel)
- leaves thin, oval, double-toothed
- bright green above, pale beneath
- rounded, heart-shaped base
- gray, smooth bark
- nut(s) in a long-necked sack

1.8 TREE IDENTIFICATION "KEYS"

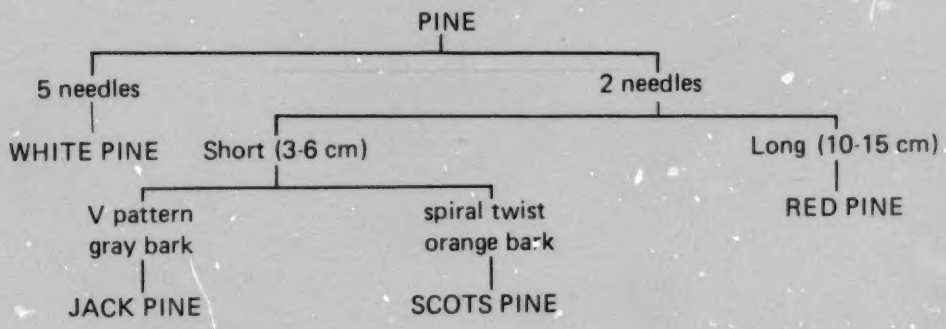
Keys are descriptive listings which provide a series of alternative choices leading to the identification of trees. Keys may be organized in many different ways. Refer to pages 347-363, NATIVE TREES OF CANADA, for additional information.

Three simple keys follow. The first may be worked out on the board. Students might then try the others on their own.

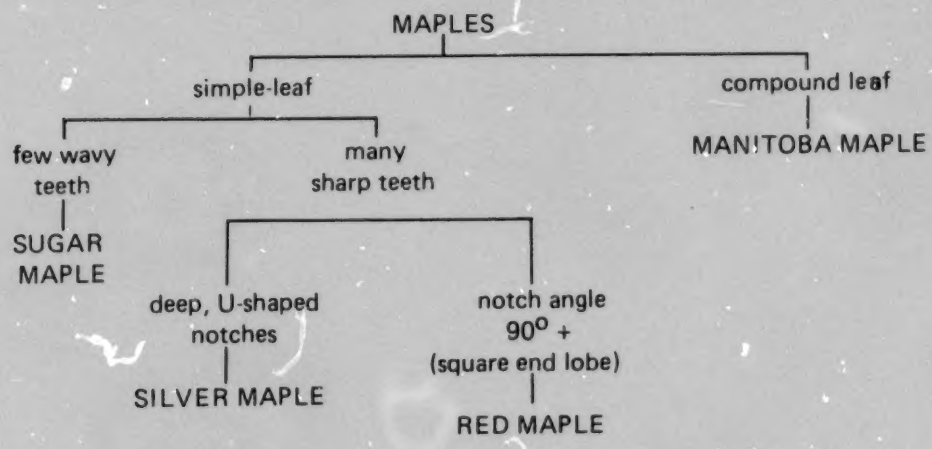
a) Key To The Conifers (p. 348)



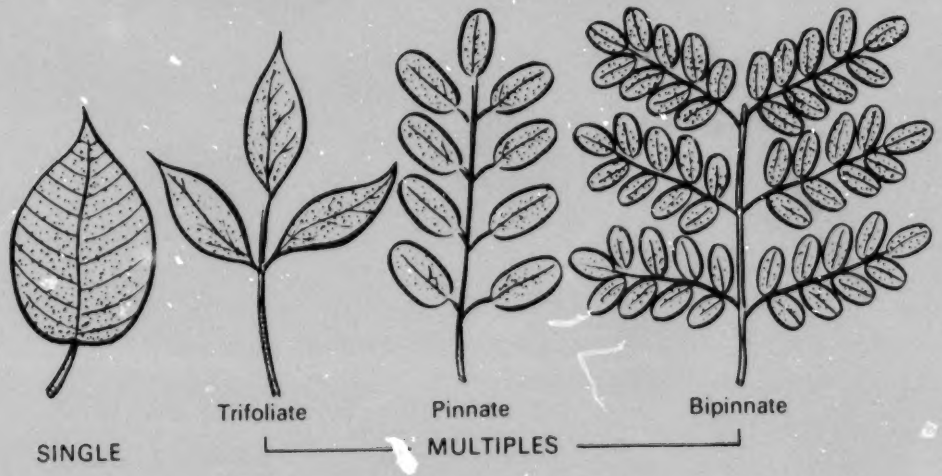
b) **Key To The Pines** (p. 349)



c) **Key To The Maples** (p. 363)



LEAF ARRANGEMENT



LEAF COLLECTION INSTRUCTIONS

You are to produce a leaf collection containing specimens from as many species as possible. The project will be marked out of a total of _____. Marks will be deducted if the project is handed in late. The completion deadline is _____.

Details

1. Use a **loose-leaf binder** or **scrapbook** which will allow for expansion. Leaves are thick.

2. On the cover note **leaf collection**, your **name**, your **class**, **date** handed in.

3. Mount the leaves as follows:

   a) Dry the leaves between sheets of newspaper in a book or magazine under a weight.
   b) Place leaves in the book with scotch tape. Conifer needles tend to fall off the twig so mount only a few of them and stick down all the needles with tape.
   c) Arrange the leaves in an appropriate order with suitable headings. Note the name of the species beside each leaf.

4. **Respect private property.** Treat it as your own. When collecting leaves it may be appropriate to ask the owner's permission. Do not tear branches from trees.

5. Leaves dry and crumple quickly when picked. Have a magazine or other firm binder with you into which the leaves can be put while on your collections.

6. The check-list below is a guide to some of the tree leaves that should be collected. Collect as many more species as you can.

Conifers

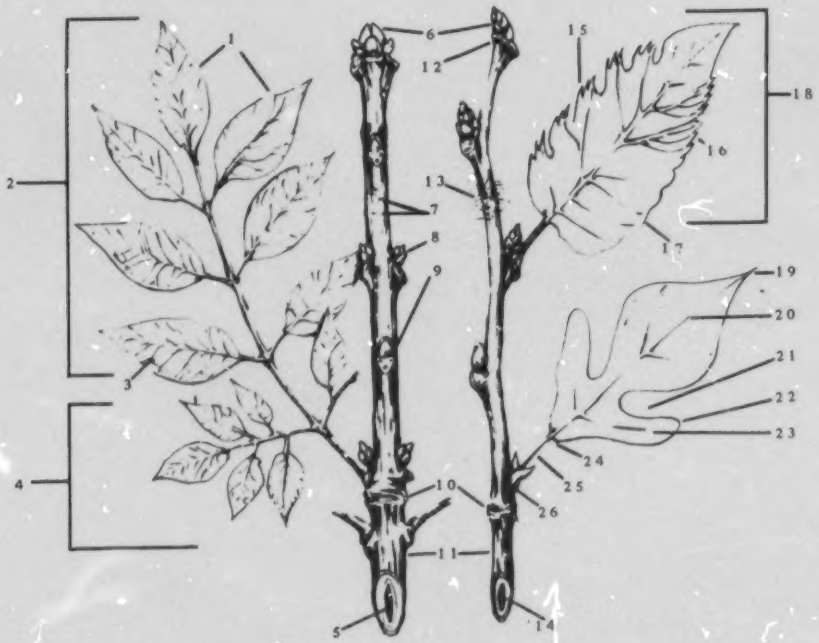
- white pine	- spruce	- tamarack
- red pine	- balsam	-
- jack pine	- cedar	-
- scots pine	- hemlock	-

Hardwoods

- sugar maple	- large-toothed aspen	- white ash
- red maple	- balsam poplar (balsam)	- black ash
- silver maple	- silver poplar	- pin cherry
- Manitoba maple	- Carolina poplar	- choke cherry
- white birch	- white oak	- black cherry
- yellow birch	- red oak	- beech
- trembling aspen	-	- elm

Instruction Sheet 1
OFA Forestry Manual

LEAVES AND TWIGS



A Compound Leaf Divided Into Leaflets | Winter Twig With Opposite Bud Arrangement | Winter Twig With Alternate Bud Arrangement | Two Simple Leaves Showing Important Identifying Features

1. Leaflets of a compound leaf
2. Singly compound leaf
3. Venation - pattern of veins
4. Doubly compound leaf
5. Solid pith - core of the stem
6. Terminal or end bud
7. Lenticels - breathing pores
8. Lateral or side buds showing bud scales (number varies per species)
9. Leaf scar showing bundle scars (fibro-vascular vessels)
10. End bud scar - from previous year's growth
11. Previous year's twig
12. Bud scale scar (twig scar) will remain when bud grows (see 10)
13. Hairs - protection (?)
14. Chambered pith - core of stem
15. Double-toothed margin
16. Single-toothed margin
17. Wavy margin
18. Leaf blade - flat part as opposed to stem
19. Leaf tip
20. Mid rib - main central vein
21. Sinus cleft or notch
22. Lobe - projection
23. Vein - vessel, tube
24. Leaf base
25. Stalk - stem, petiole
26. Stipules - leaf-like organs

Instruction Sheet 2
OFA Forestry Manual

FIELD TRIP
REPORT

Name _____
Class _____ Date _____

PENAGE ROAD – BLACK CREEK AREA – WEST OF BRIDGE

1. Describe the site: soil type _____ soil moisture _____

2. Estimate the age of the jack pine stand: _____ years

3. Estimate the average diameter of the jack pine 1.3 m above the ground. _____ cm

4. Do you think the stand started from natural regeneration or was it planted by people? Give your reasons.

5. a) Red pine was planted under the jack pine in places. Why?

   b) How healthy (vigorous) are these underplanted red pine?

PENAGE ROAD – EAST OF BRIDGE

6. If you see these in this area put a check mark beside their names

   white pine ____ red pine ____ jack pine ____ Scots pine ____ spruce ____ balsam ____
   hemlock ____ cedar ____ tamarack ____ trembling aspen ____ large-tooth aspen ____
   balsam poplar ____ sugar maple ____ red maple ____ silver maple ____ Manitoba
   maple ____ red oak ____ white oak ____ elm ____
   OTHERS (name them) _____

OLD NAIRN ROAD – NEAR RAILWAY CROSSING

7. The red pine stand in the south-west corner:

   a) Is it natural or was it planted? Explain your answer.

   b) How old do you think the red pines are? _____ years.

8. The field in the north-west corner was planted with spruce about 15 years ago. What was the purpose of this planting and what has happened to it?

9. The jack pine in the south-east corner looks crowded with the trees too close together.

   a) What **problem** does this crowding produce?

   b) Can you think of one or two **advantages** of crowding?

   c) If it was your jack pine stand, what would you do about the crowding?

10. The poplar north of the road:

   a) Do you think it is vigorous and healthy? Why?

   b) What do you think will happen eventually to this poplar stand?

   c) Can you suggest any forestry work that might be done here to improve the stand?

OLD NAIRN ROAD – NELSON CREEK AREA

11. a) What kinds of pine have been planted south of the road?

   b) Can you see anything indicating problems involving tree growth and development?

FIELD, NORTH-WEST OF HIGHWAY AND OLD WEBBWOOD ROAD
(Old Sokoloski Farm)

12. a) Were the trees in this field started naturally from seed or were they planted?

   b) If from seed, where did the seed come from?

   c) List all the conifer species you can identify in this field.

   d) Note the cases of "weevilled" white pine leader shoots.

TREE DESCRIPTION REPORT

Name _____

Class _____ Date _____

Describe the following trees. Note all the details you can.

1. Conifer Tree

   Species: _____

   a) needles _____
   b) bark _____
   c) estimate of tree diameter at 1.3 m above the ground _____ cm
   d) estimate of height of tree: _____ m
   e) sketch of fruit

2. Deciduous Tree

   Species: _____

   a) sketch the leaf outline on the back of this page.
   b) describe the bark _____
   c) estimate of tree diameter at 1.3 m above the ground _____ cm
   d) estimate of height of tree. _____ m
   e) opposite or alternate branching? _____

3. Describe the "site" – ie. the place the trees are growing.

   a) soil (sand, clay, loam, etc.) _____
   b) topography (flat, sloping, hilly, etc.) _____
   c) shade (dense, medium, slight) _____
   d) other details (wet or dry, etc.) _____

4. Do the trees look healthy? _____

5. Comments about the trees: _____
   _____
   _____
   _____

6. If you were to estimate the diameters and heights of all the _____ (species) trees on this area how would you find the average diameter and the average height of the trees here? Explain. _____
   _____

UNIT 2
FORESTRY MEASUREMENTS

UNIT 2: FORESTRY MEASUREMENTS

OBJECTIVE

Students should be able to make tree measurements, record these simply, and understand sampling methods to obtain estimates of wood volumes in standing forests (cruising) and in logs (scaling).

2.1 METHODS OF RECORDING MEASUREMENTS (TALLYING)

If a number of tree diameters are measured the record may show something like this:

14, 18, 12, 26, 10, 14, 14, 22, 12, 18, 26, etc.

This can be greatly simplified by various methods of "tallying" or recording. For example:

Number	1	2	3	4	5	6	7	8	9	10	14
Method A	/	//	///	////	𝍸	𝍸 /	𝍸 //	𝍸 ///	𝍸 ////	𝍸 𝍸	𝍸 𝍸 ////
Method B	•	• •	• • •	• • • •	• • • •	• • • •	• • • •	• • • •	• • • •	• • • •	• • • •
Method C	•	••	••	••	••	••	••	••	••	••	••

Method C is the one used by the Ministry of Natural Resources and it will be used in this manual. Students should be familiar with all three methods. Are there others? What are the advantages of "tallying" in space and time?

The word tally comes from the Latin word talea – a stick. Students may wish to learn more about it from a good dictionary.

Students should show that they understand the three systems by tallying various numbers (8, 29, etc.) in the three ways.

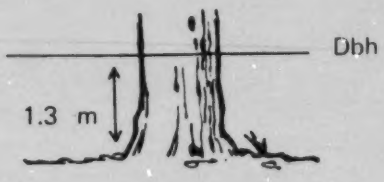
2.2 TREE DIAMETER MEASUREMENTS

The diameter of a tree is its width. This measurement is important in determining tree volumes and growth rates.

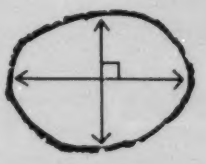
a) Dbh – Diameter Breast Height

Diameter measurements on standing trees are made at **1.3 metres** above the ground. Why Dbh? This is the highest one can go to avoid the root flare and still read the diameter properly.

One should become familiar with the point on one's body which is 1.3 m high. This will make it simple to find the right level at which to make the tree diameter measurement.



If a tree is not circular measure its diameter through the largest and smallest dimensions, at right angles, and then average the two.



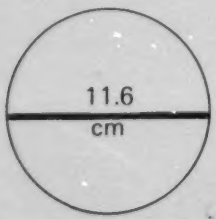
Dbh is usually measured using wood or steel **calipers**. For more accurate measurements **diameter tapes** may be used. These go around the circumference of the tree but give the diameter reading directly on the tape.

These measurements are made outside the bark. To measure only wood diameter a **bark thickness gauge** is used and double the bark thickness is subtracted from the outside diameter.

b) Diameter Classes

Tree diameters are usually recorded in whole numbers. The rules call for measuring standing tree diameter classes in **2-centimetre units. Read down** to the next lower even number.

eg. 11.6 cm is tallied as 10 cm
8.7 cm is tallied as 8 cm
21.5 cm is tallied as 20 cm



= 10 cm. tree

c) Weighted Averages

(This section may be omitted. However, they are more accurate than simple averages in many circumstances and they are used extensively in forestry.)

Weighted averages are averages which take into account number distribution.

For example:

Diameter D (cm)	No. of Trees N
20	3
26	42

- The simple average tree diameter in the sample measured is $\frac{20 + 26}{2} = 23$ cm
- The true average is higher than 23 cm because there are so many more 26 cm trees than 20 cm trees.

To find the weighted average

Multiply the number of trees in each diameter class by each diameter. Total the sum of all these and divide by the number of trees.

	D cm	Tally	No.	D x N
	20	⁘	2	40
	22	⁘	3	66
6	24	⁘	6	144
diam.	26	⁘	4	104
classes	28	⁘	12	336
	30	⁘	10	300
	150	37	37	990

$$\text{Simple average} = \frac{150}{6} = 25 \text{ cms}$$

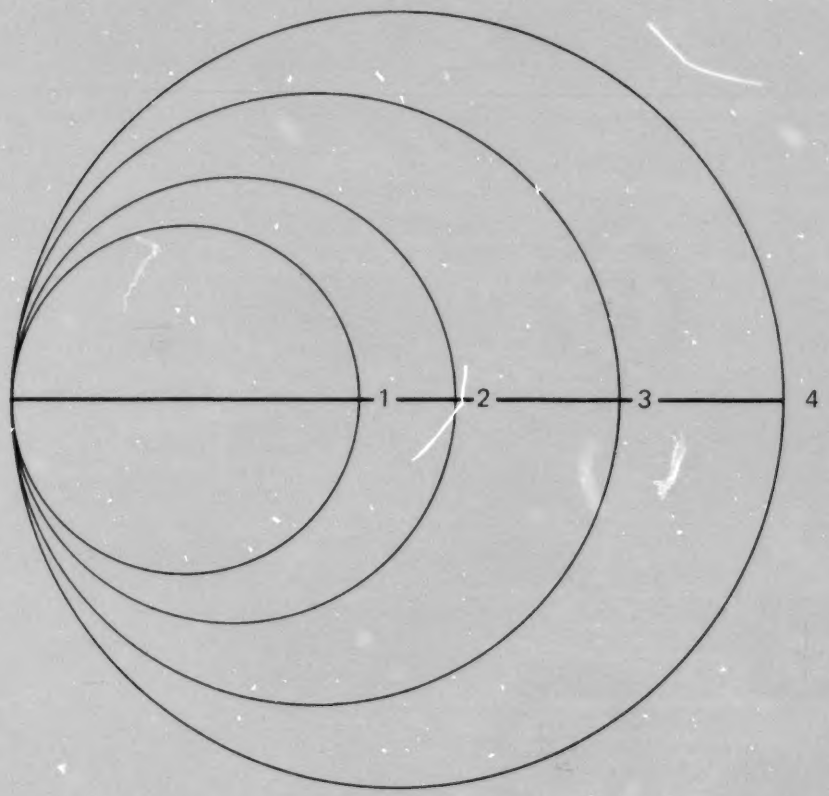
$$\text{Weighted average} = \frac{990}{37} = 26.7 \text{ cms}$$

CLASSROOM CALIPER EXERCISE

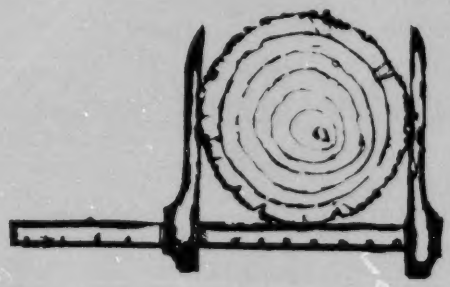
Name _____
Class _____ Date _____

What are diameters of:

Circle 1	cms.
Circle 2	cms.
Circle 3	cms.
Circle 4	cms.



Note:
Be sure back arm of caliper touches the circle to be measured.



Instruction Sheet 5
OFA Forestry Manual

TREE DIAMETER TALLY SHEET

Name _____
Partner _____
Class _____ Date _____

Equipment needed – tree calipers or diameter tapes, tally sheets, clip boards, pencils.

Procedure
- Work in pairs. **Each** student is to turn in a completed tally sheet. (Finish one outside. Copy the data on to the other one later.)
- Measure and tally **all** trees within the size limits shown. We will not separate the trees by species in this exercise.
- Tally by the 10 = ⊠ **method**
- If a specific area is used all members of the class should tally the same result.
- Make the tally in the line beside the diameter class. Total the tally for each diameter class and write it in numbers in the third column.

Tally

Diam (cms)	Tally	No.
16		
18		
20		
22		
24		
26		
28		
30		
32		
34		
36		
38		
Total		

Diam (cms)	Tally	No.
40		
42		
44		
46		
48		
50		
52		
54		
56		
58		
60		
62		
Total		

2.3 AGE MEASUREMENTS

The age of trees is important in determining the rate of growth to date and the likelihood of growth in future. Some trees are very short-lived. Others live for a few hundred years. Few Ontario trees live past 300 years.

Three methods of measuring age are:

a) ring count
b) branch whorls (some species)
c) height

a) Ring Counts

i) Dead trees, logs.

This may be demonstrated using logs, stumps or diagrams.

The clearness of rings varies considerably depending upon the species, growth and condition of the wood. Also, where a power saw has done the cutting the surface may be very rough.

Suggested procedure

Count the rings **from the centre out.** Mark every tenth ring with a pencil. This will reduce the risk of error.

A magnifying glass may help. If the rings are indistinct some careful estimating will be necessary.

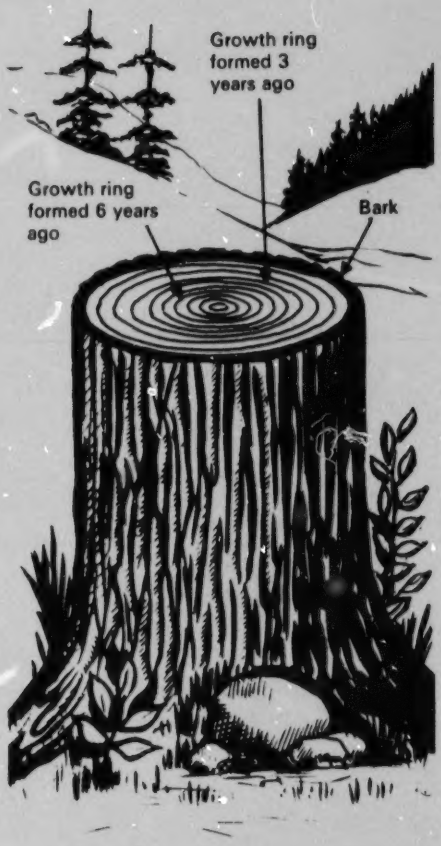
Total the number of rings. **Then add** the estimated number of years it took the tree to grow to that height. This will give the age of the tree. Remember, the higher up a tree you go the younger that point of it is. (More on this in the study of tree growth that follows.)

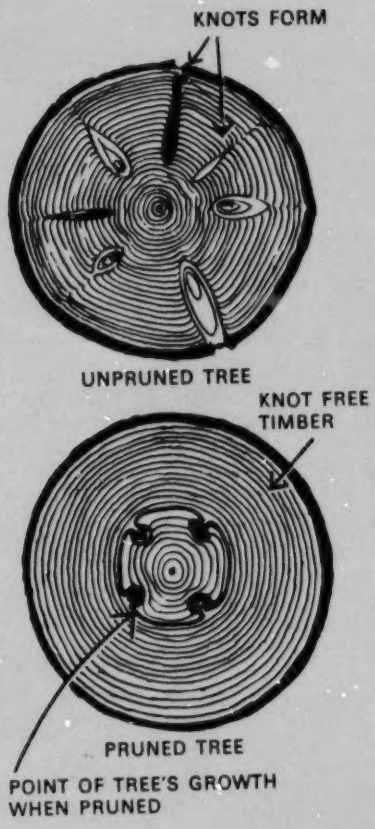
ii) Living trees

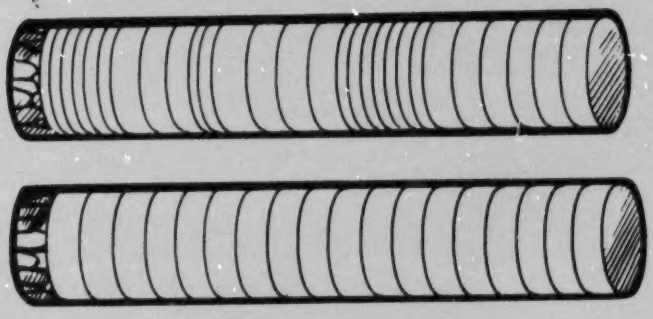
Increment borers consist of a hollow metal tube sharpened and threaded at one end and equipped with a handle at the other. The hollow tube is screwed into the tree, an "extractor" is forced down the tube and a wooden core is removed when the extractor is pulled out. The rings on the core can be examined without cutting down the tree.

Uses: (1) To determine age
(2) To measure growth rate
(3) To check tree and area history
(4) To determine interior conditions (rot, etc.)

TREE AGE







Cores removed with increment borer from 2 trees show different growth rates.

b) Branch Whorls

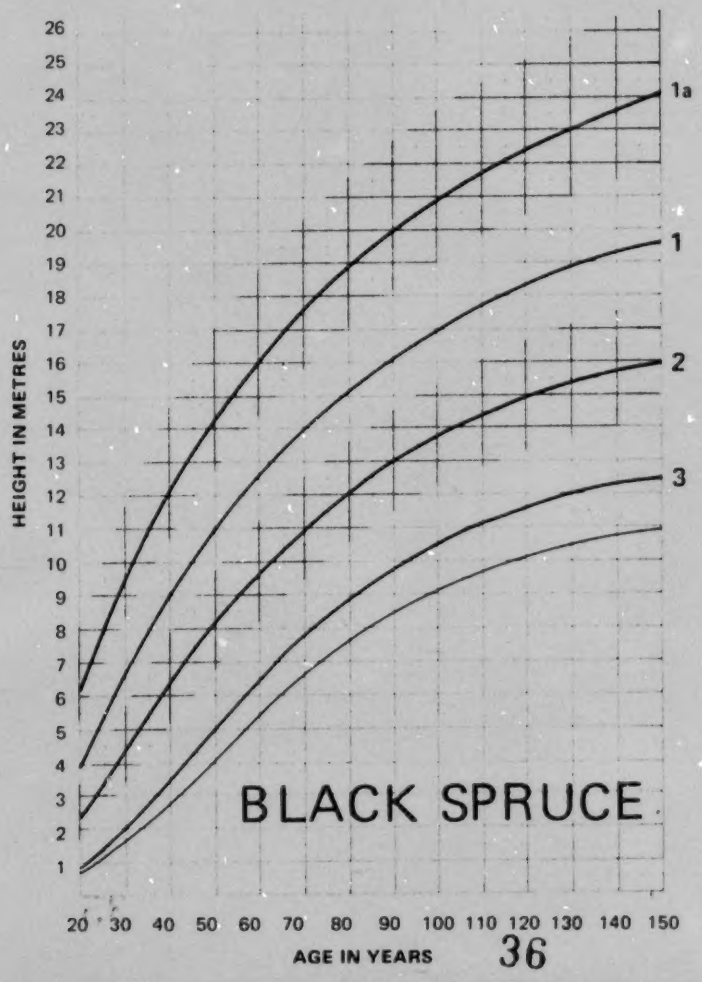
A whorl of branches refers to a ring or layer of branches. These are found commonly in some species (eg. red and white pine) where the new branches begin from buds only at the tip of the branch. Some species (eg. spruce) produce some buds at the tip of last year's growth but also down the sides of it. The result is indistinct whorls. Where the whorl is clearly evident it represents one year's growth.

Count the number of whorls **then add** the estimated number of years it took the tree to reach the lowest whorl.

Evidence of the whorl of branches can be found on some older trees long after the branches have fallen off.

c) Tree Height

Tree height can give a **rough estimate** of age sometimes. Many conifers growing on good sites in a particular area may average 30 cms of height growth per year. Others on poorer sites may grow less. Other species, such as poplar, may grow six feet or so in one year.



2.4 GROWTH MEASUREMENTS

Measurements of tree growth are necessary to determine the volumes of wood we may expect to have on a given area barring catastrophe in the years ahead.

Growth can be **measured** in terms of **height**, **diameter** and **volume** over various periods of **time**.

Most tree growth takes place in the spring with a limited amount in the summer. Height and diameter growth are different processes that take place at the same time.

a) Height Growth

Height growth takes place as the terminal or **lead bud** opens and the contents expand and develop into a new year's growth. By the fall a new terminal bud will have formed and be ready to provide the next annual addition to the height growth when spring comes around again.

ACTIVITY – Measure the current year's height growth of several trees.

b) Diameter Growth

Diameter growth is the result of cell division in the **cambium**, a thin cell layer which divides to produce more cambium cells, new wood on the inside and new bark on the outside.

What makes annual rings in wood?

The wood cells produced by the cambium in the spring are, in many species, large open cells. (**springwood**).

When summer comes the growth slows down and the new cells are smaller, thicker-walled and tightly packed. (**summerwood**) It appears as a line.

The difference in appearance of these two produces what is called an **annual ring** and this contains both the spring and summer wood.

When we count the annual rings we generally count the summer wood bands for they show up most clearly.

These same rings account for the **grain** or pattern in wood. They are found in both **sapwood** and **heartwood**.

TREE AND AREA HISTORY

1914
When the tree was six years old, something pushed against it, making it lean. The rings are now wider on the lower side, as the tree builds "reaction wood" to help support it.

1924
The tree is growing straight again. But its neighbours are growing too and their crowns and root systems take much of the water and sunshine the tree needs.

1927
The surrounding trees are harvested. The larger trees are removed and there is once again ample nourishment and sunshine. The tree can now grow rapidly again.

1930
A fire sweeps through the forest. Fortunately, the tree is only scarred, and year by year more and more of the scar is covered over by newly formed wood.

1942
These narrow rings may have been caused by a prolonged dry spell. One or two dry summers would not have dried the ground enough to slow the tree's growth this much.

1957
Another series of narrow rings may have been caused by an insect like the larva of the sawfly. It eats the leaves and buds of many kinds of coniferous trees.

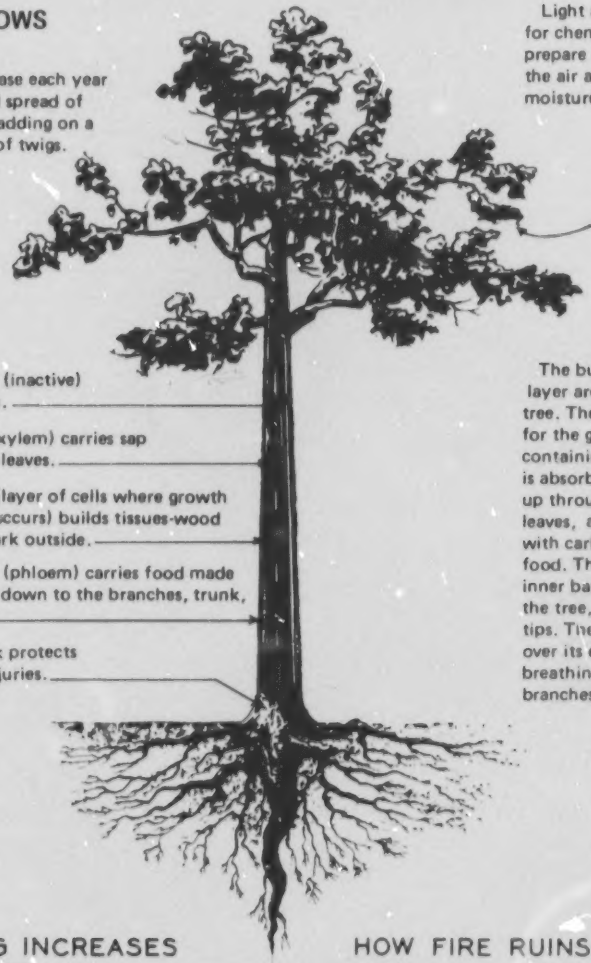
Courtesy St. Regis Paper Co. New York

HOW A TREE GROWS

Trees increase each year in height and spread of branches by adding on a new growth of twigs.

Light and heat are necessary for chemical changes. The leaves prepare the food obtained from the air and the soil and give off moisture by transpiration.

The air supplies carbon, the principal food of the tree, which is taken in on the under surface of the leaves.



Heartwood (inactive) gives strength.

Sapwood (xylem) carries sap from root to leaves.

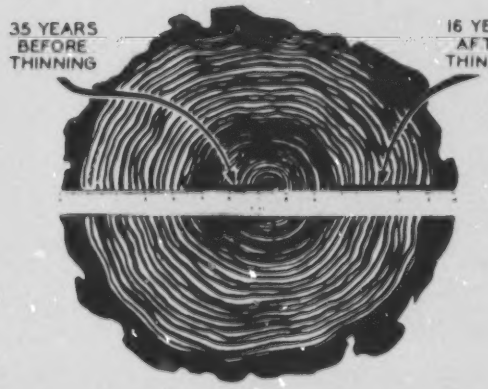
Cambium (layer of cells where growth in diameter occurs) builds tissues-wood inside and bark outside.

Inner bark (phloem) carries food made in the leaves down to the branches, trunk, and roots.

Outer bark protects tree from injuries.

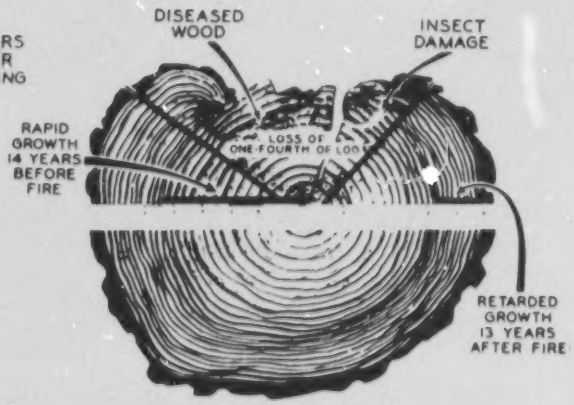
The buds, root tips, and cambium layer are the growing parts of the tree. The leaves manufacture food for the growing processes. Water, containing minerals in solution, is absorbed by the roots, carried up through the sapwood to the leaves, and is there combined with carbon from the air to make food. This food is carried by the inner bark to all growing parts of the tree, even down to the root tips. The tree takes in oxygen over its entire surface through breathing pores on leaves, twigs, branches, trunk, and roots.

HOW THINNING INCREASES GROWTH



HOW FIRE RUINS TIMBER

DISEASE AND INSECTS ENTER THROUGH FIRE SCARS


DISEASED WOOD
INSECT DAMAGE
RAPID GROWTH 14 YEARS BEFORE FIRE
LOSS OF ONE FOURTH OF LOG
RETARDED GROWTH 13 YEARS AFTER FIRE

Instruction Sheet 9
OFA Forestry Manual

A mature tree trunk has **five main layers:**

Heartwood – in the centre, older, inactive, gives strength.

Sapwood – (xylem) younger, active, carries sap from roots to leaves.

Cambium – thin layer of cells between the sapwood and the inner bark, growth centre, adds wood (xylem) inside and inner bark (phloem) outside, forms a sheath over trunk twigs and branches.

Inner Bark (Phloem) – young, active, carries food made in the leaves down to the roots, trunk and branches.

Outer Bark – old phloem forms a protective covering around the tree. What happens to it as the tree expands in diameter?

Remember – It should be understood that the sap goes up the tree in the sapwood while the food manufactured in the leaves (by photosynthesis) goes down in the inner bark.

ACTIVITY – Measure the growth in diameter in one year and ten year intervals on a log or board. If the width of the annual ring is one quarter inch what would the diameter growth of the tree be?

c) Volume Growth

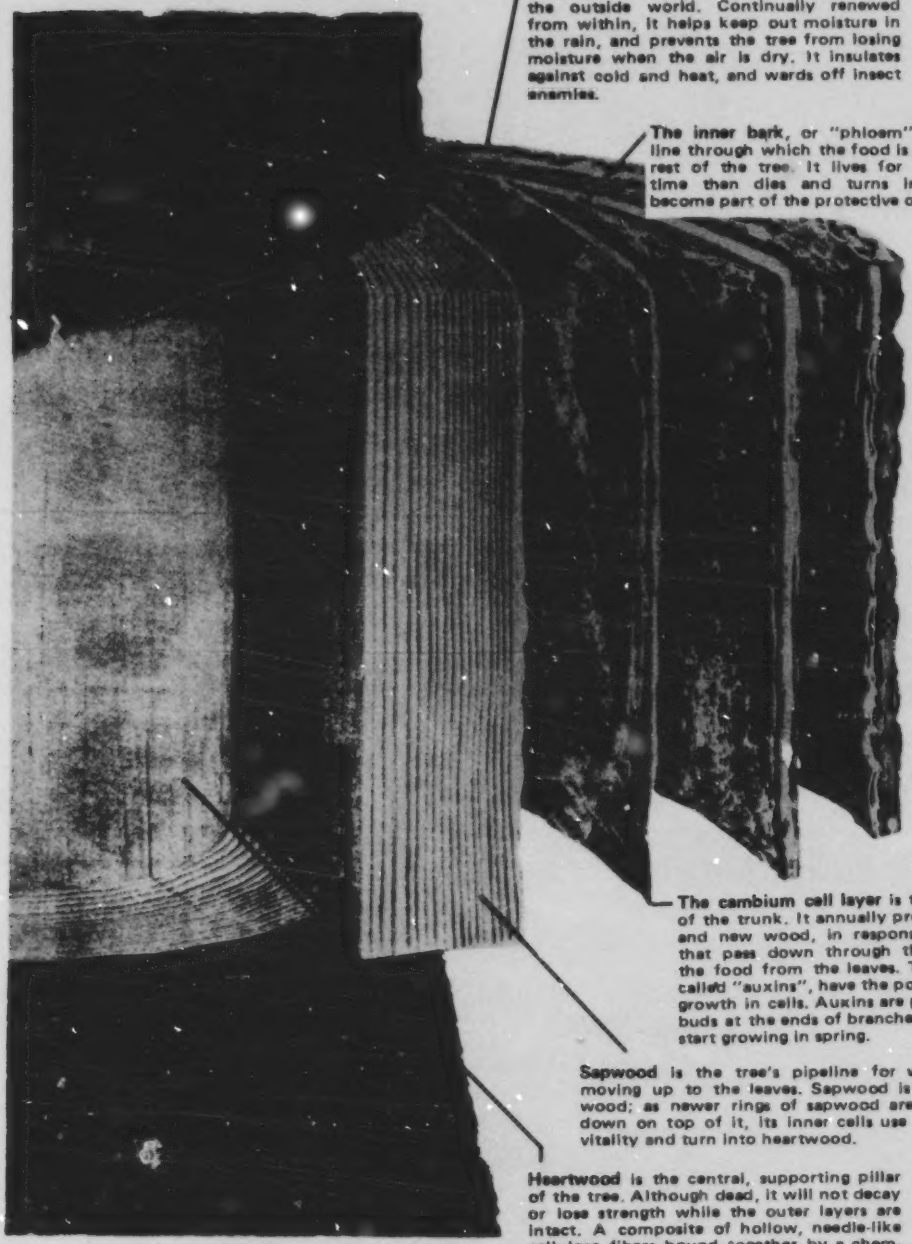
How much wood does a tree grow? It is not easy to measure the annual growth in the branches but the trunk growth can be measured quite easily with an increment borer or a "dendrometer tape" fixed to a tree and read each year.

The trunk of conifers tends to be cone shaped from bottom to top. In hardwoods the branch-free trunk tends to be most valuable and it is in the shape (more or less) of a cylinder.

It is common in forestry work to use **volume tables** rather than figuring out the volume of every tree. Volume tables may be calculated for very small areas or large ones depending upon the accuracy required. They take into account the heights and diameters of the trees and provide a volume for each diameter class. By counting the number of trees of each diameter class one can simply go to the volume tables and calculate the total volume. (The volume of wood in an 80 cm tree that is 20 m tall will be different than that for one 30 m high. The local volume tables take the local tree heights into consideration).

BEST COPY AVAILABLE

TREE ANATOMY



The outer bark is the tree's protection from the outside world. Continually renewed from within, it helps keep out moisture in the rain, and prevents the tree from losing moisture when the air is dry. It insulates against cold and heat, and wards off insect enemies.

The inner bark, or "phloem" is the pipeline through which the food is passed to the rest of the tree. It lives for only a short time then dies and turns into cork, to become part of the protective outer bark.

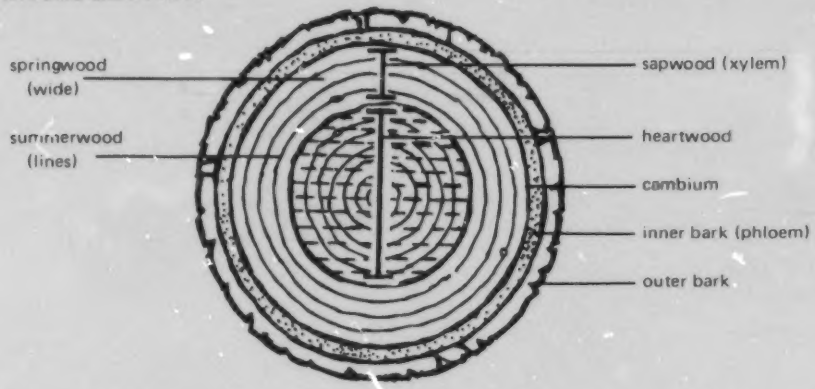
The cambium cell layer is the growing part of the trunk. It annually produces new bark and new wood, in response to hormones, that pass down through the phloem with the food from the leaves. These hormones, called "auxins", have the power to stimulate growth in cells. Auxins are produced by leaf buds at the ends of branches as soon as they start growing in spring.

Sapwood is the tree's pipeline for water moving up to the leaves. Sapwood is new wood; as newer rings of sapwood are laid down on top of it, its inner cells use their vitality and turn into heartwood.

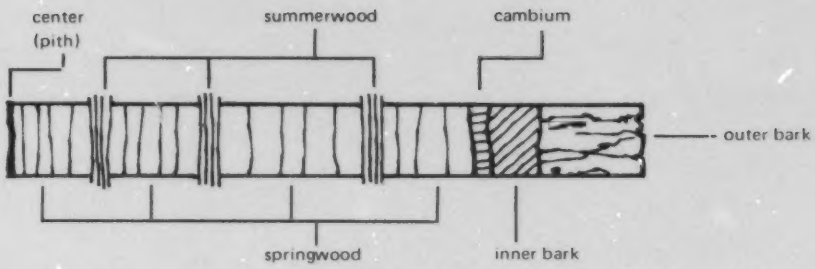
Heartwood is the central, supporting pillar of the tree. Although dead, it will not decay or lose strength while the outer layers are intact. A composite of hollow, needle-like cellulose fibers bound together by a chemical glue called lignin, it is in many ways as strong as steel. A piece 12" long and 1" by 2" in cross-section, set vertically, can support the weight of 20 tons.

courtesy St. Regis Paper Co., New York

TREE CROSS-SECTION



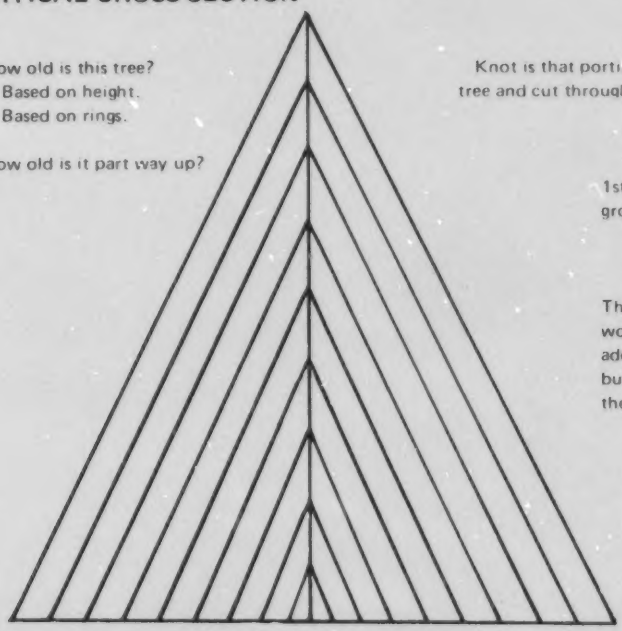
CORE OF WOOD



VERTICAL CROSS-SECTION

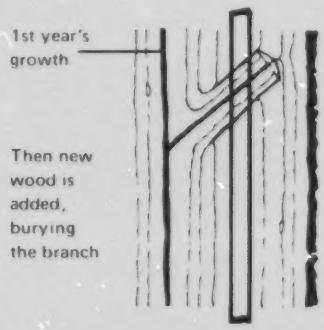
How old is this tree?
– Based on height.
– Based on rings.

How old is it part way up?



KNOTS IN WOOD

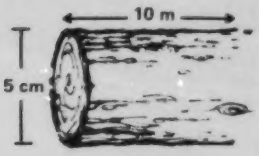
Knot is that portion of a branch or limb embedded in the tree and cut through in the process of lumber manufacture.



One can compare growth rates of trees on various areas by boring a few trees to remove cores and by then measuring the growth of the trees over the past 10 years or whatever period required. If growth is slowing down harvest may be recommended. If vigorous growth is continuing the forester may elect to leave the trees longer.

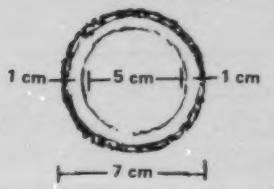
(This is one possible use of the tree growth measurements. It is not always done and not always the best indicator of when to cut.)

ACTIVITY – It may be useful to have the students calculate the volume of growth in one annual ring on a cylinder of 10 metres long. Suppose the annual ring is 1 cm wide. It is on both sides, remember.



The tree is going to grow from 5 cm to (5 + 1 + 1 =) 7 cm in one year. The growth is 2 cm in diameter. The area of the end of the log (πr^2) at 5 cm = $\pi \times \frac{5}{2} \times \frac{5}{2} = \frac{22}{7} \times \frac{25}{4} = 19.64\ cm^2$

The area at the end of the log at 7 cm = $\pi \times \frac{7}{2} \times \frac{7}{2} = \frac{22}{7} \times \frac{49}{4} = 38.49\ cm^2$

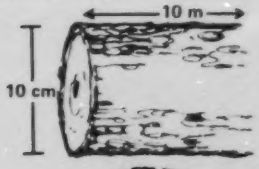


The volume of the former on a 10 metre log = 19.64 cm^2 x 1000 cm = 19,640 cm^3

The volume of the latter on a 10 metre log: 38.49 cm^2 x 1000 cm = 38,490 cm^3

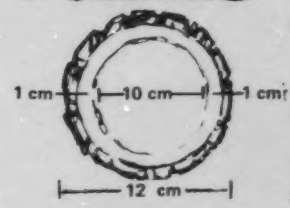
In other words the volume of wood in the 5 cm tree increased from 19,640 cm^3 to 38,490 cm^3 (practically double) by growing 2 cms in diameter in the one growing season. The actual increase was (38,490 – 19,640 =) 18,850 cm^3.

Now compare this with a log of 10 cm in diameter which adds the same 1 cm of growth in an annual ring. (on each side)



Vol. of log at 10 cm = $\pi \times \frac{10}{2} \times \frac{10}{2} \times 1000 = 78539.8\ cm^3$

Vol. of log at 12 cm = $\pi \times \frac{12}{2} \times \frac{12}{2} \times 1000 = 113{,}097.3\ cm^3$



Difference = 113,097 – 78,539 = 34,558 cm^3

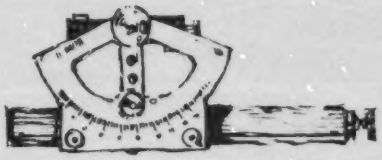
The log 10 cm in diameter put on nearly 35 thousand cubic centimetres in one year. The 5 cm log put on nearly 19 thousand cubic centimetres of wood in one year. What does this tell us about big versus little trees?

2.5 TREE HEIGHT MEASUREMENTS

As noted in 2.3 the tree height is required in the calculation of total tree volume. It is also an indicator of the quality of the site and the vigor of the tree when considered in relation to age and diameter. Big trees yield more wood than small trees in equal time and their seed may be useful in growing better seedlings in tree nurseries for reforestation purposes.

There are several ways of measuring the heights of standing trees or other objects of which four follow:

a) Using An Abney Level



The **topographic Abney level** permits the measurement of the **angle** between a line horizontal to the viewer's eye level and the point above or below that line which is being sighted.

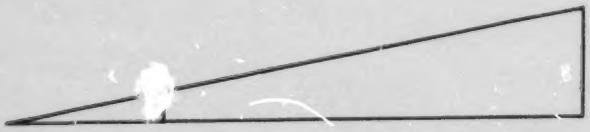
By looking through the sighting tube you can fix a sight upon the point to be measured, adjust the spirit level bubble to the horizontal position and simply read the angle on the arc. With **this angle and the measured distance** to the tree you can calculate the height or depth of the point above or below eye level by using trigonometry **tangent values** obtained from tables. (See page 39).

The basic formula for right angle triangles is:

$$\text{Tangent} = \frac{\text{Opposite side}}{\text{Adjacent side}}$$

or

$$\text{Opposite} = \text{Tangent} \times \text{Adjacent}$$



eg. Suppose the angle = 30 degrees
distance = 20 metres

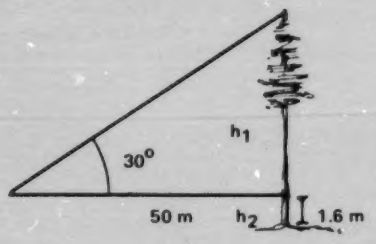
Opposite (height) = Tan x Adj = 0.5774 x 20 = 11.548 m

TABLE OF TRIGONOMETRIC RATIOS

θ	sin	cos	tan
0	0.0000	1.0000	0.0000
1	0.0175	0.9998	0.0175
2	0.0349	0.9994	0.0349
3	0.0523	0.9986	0.0524
4	0.0698	0.9976	0.0699
5	0.0872	0.9962	0.0875
6	0.1045	0.9945	0.1051
7	0.1219	0.9925	0.1228
8	0.1392	0.9903	0.1405
9	0.1564	0.9877	0.1584
10	0.1736	0.9848	0.1763
11	0.1908	0.9816	0.1944
12	0.2079	0.9781	0.2126
13	0.2250	0.9744	0.2309
14	0.2419	0.9703	0.2493
15	0.2588	0.9659	0.2679
16	0.2756	0.9613	0.2867
17	0.2924	0.9563	0.3057
18	0.3090	0.9511	0.3249
19	0.3256	0.9455	0.3443
20	0.3420	0.9397	0.3640
21	0.3584	0.9336	0.3839
22	0.3746	0.9272	0.4040
23	0.3907	0.9205	0.4245
24	0.4067	0.9135	0.4452
25	0.4226	0.9063	0.4663
26	0.4384	0.8988	0.4877
27	0.4540	0.8910	0.5095
28	0.4695	0.8829	0.5317
29	0.4848	0.8746	0.5543
30	0.5000	0.8660	0.5774
31	0.5150	0.8572	0.6009
32	0.5299	0.8480	0.6249
33	0.5446	0.8387	0.6494
34	0.5592	0.8290	0.6745
35	0.5736	0.8192	0.7002
36	0.5878	0.8090	0.7265
37	0.6018	0.7986	0.7536
38	0.6157	0.7880	0.7813
39	0.6293	0.7771	0.8098
40	0.6428	0.7660	0.8391
41	0.6561	0.7547	0.8693
42	0.6691	0.7431	0.9004
43	0.6820	0.7314	0.9325
44	0.6947	0.7193	0.9657

θ	sin	cos	tan
45	0.7071	0.7071	1.0000
46	0.7193	0.6947	1.0355
47	0.7314	0.6820	1.0724
48	0.7431	0.6691	1.1106
49	0.7547	0.6561	1.1504
50	0.7660	0.6428	1.1918
51	0.7771	0.6293	1.2349
52	0.7880	0.6157	1.2799
53	0.7986	0.6018	1.3270
54	0.8090	0.5878	1.3764
55	0.8192	0.5736	1.4281
56	0.8290	0.5592	1.4826
57	0.8387	0.5446	1.5399
58	0.8480	0.5299	1.6003
59	0.8572	0.5150	1.6643
60	0.8660	0.5000	1.7321
61	0.8746	0.4848	1.8041
62	0.8829	0.4695	1.8807
63	0.8910	0.4540	1.9626
64	0.8988	0.4384	2.0503
65	0.9063	0.4226	2.1445
66	0.9135	0.4067	2.2460
67	0.9205	0.3907	2.3559
68	0.9272	0.3746	2.4751
69	0.9336	0.3584	2.6051
70	0.9397	0.3420	2.7475
71	0.9455	0.3256	2.9042
72	0.9511	0.3090	3.0777
73	0.9563	0.2924	3.2709
74	0.9613	0.2756	3.4874
75	0.9659	0.2588	3.7321
76	0.9703	0.2419	4.0108
77	0.9744	0.2250	4.3315
78	0.9781	0.2079	4.7046
79	0.9816	0.1908	5.1446
80	0.9848	0.1736	5.6713
81	0.9877	0.1564	6.3138
82	0.9903	0.1392	7.1154
83	0.9925	0.1219	8.1443
84	0.9945	0.1045	9.5144
85	0.9962	0.0872	11.4301
86	0.9976	0.0698	14.301
87	0.9986	0.0523	19.081
88	0.9994	0.0349	28.636
89	0.9998	0.0175	57.290
90	1.0000	0.0000	

Sample Problem



Given – distance from tree = 50 m
– angle to tree top = 30°
– eye level to ground = 1.6 m

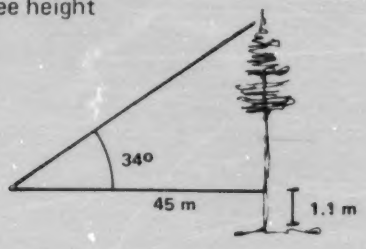
Find – tree height ($Ht = h_1 + h_2$)

$h_1 = Opp = Tan \times Adj = 0.5774 \times 50 = 28.87$ m

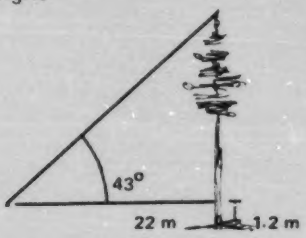
$h_1 + h_2 = 28.87 + 1.6 = \mathbf{30.47}$ = tree height

Try the following:

i) Find the tree height

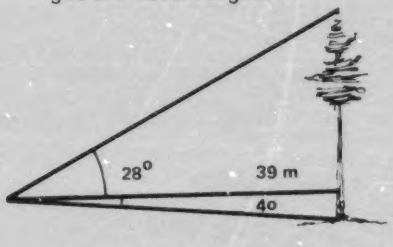


ii) Find the tree height

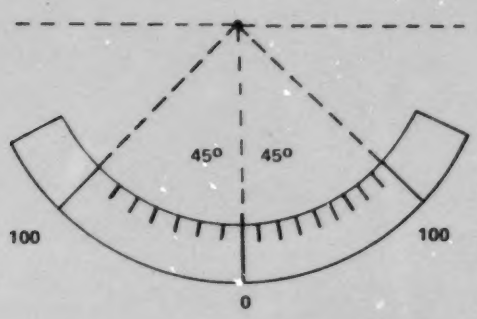


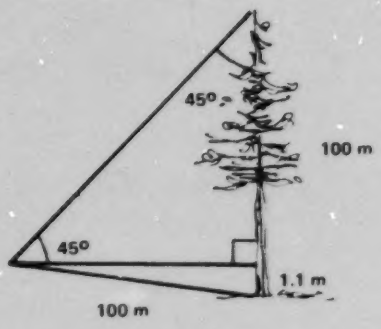
iii) Find the tree height

Note: In this case you calculate the two readings and add their values together to get the total height.



The **percent Abney level** is easier to use where a standard sighting distance to the tree can be used. At 100 metres – a long way to see through the forest – the reading could be read directly from the scale.

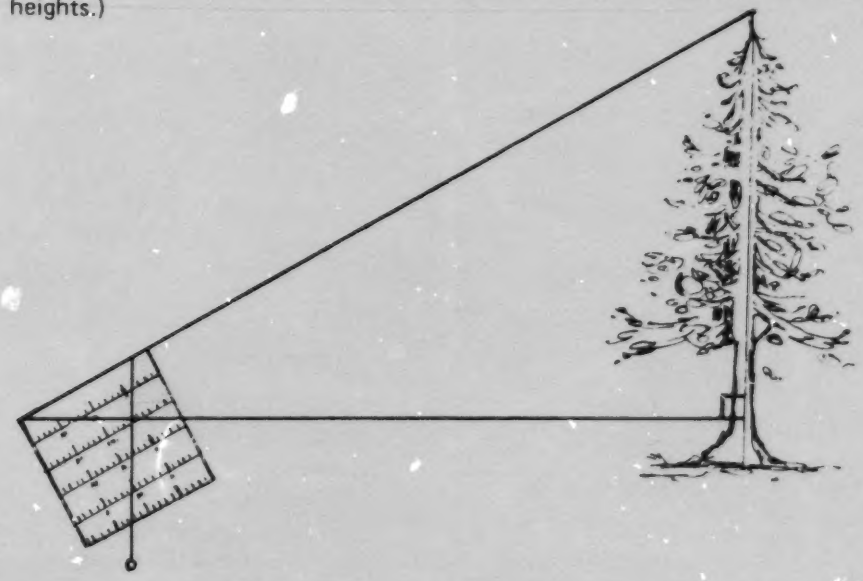




At **100 metres** the sightings to the top and bottom of the tree can be simply added together to get the total tree height.

A shorter distance would be more likely to be free of trees obstructing your sight. At **20 metres** the readings on the arc would need to be **divided by five** to give a percent reading based upon 100 metres.

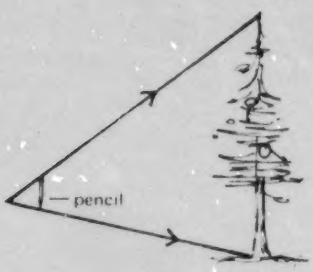
The principles upon which the Abney is based are simple and can be easily remembered through familiarity with the **cardboard hypsometer** (a device for measuring tree heights.)

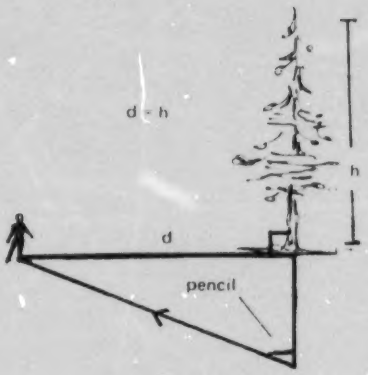


The plumb bob is substituted for the bubble level in the Abney. Scales for use 100 m, 75 m, 50 m and 25 m away from the tree permit easy reading of the correct height directly from the appropriate scale.

b) Pencil Method

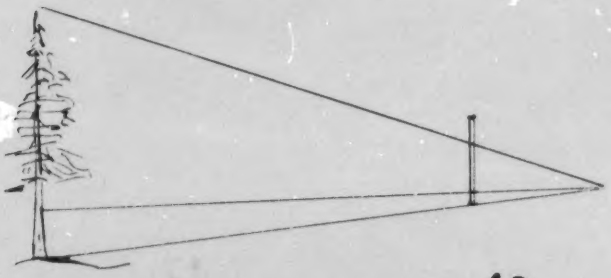
- A partner is needed.
- A pen or short stick will do in place of the pencil.
- Stand back from the tree a distance greater than the tree's height, ie. further than the tree is tall.
- Hold the pencil vertically in front of your eye. Move it back and forth until the top of the pencil is in line with the top of the tree and the base of the pencil is in line with the base of the tree.
- **Keeping the pencil at the same distance from your eye** turn it horizontally so that the bottom still lines up with the base of the tree.
- **Direct your partner** to stand on a point that is in line with the top of now horizontal pencil and at right angles from the tree.
- Measure the distance from your partner to the tree and this will give you the tree height.
- The ground should be fairly level for this method.





c) Multiplying A Known Height

- Mark the trunk of the tree at a known height eg. 2 metres.
- Stand back from the tree **further than the tree is tall.**
- Hold a ruler vertically in front of your eye and line up the ruler so that the base of the ruler is in line with the base of the tree and the 2 cm mark on the ruler is in line with the 2 metre mark on the tree.
- Keep the ruler in the same position but glance up the ruler and read the point on it at which the line of sight to the top of the tree crosses it. This will give the **tree height in metres** since two on the ruler corresponds to two on the tree. (Other combinations are possible).



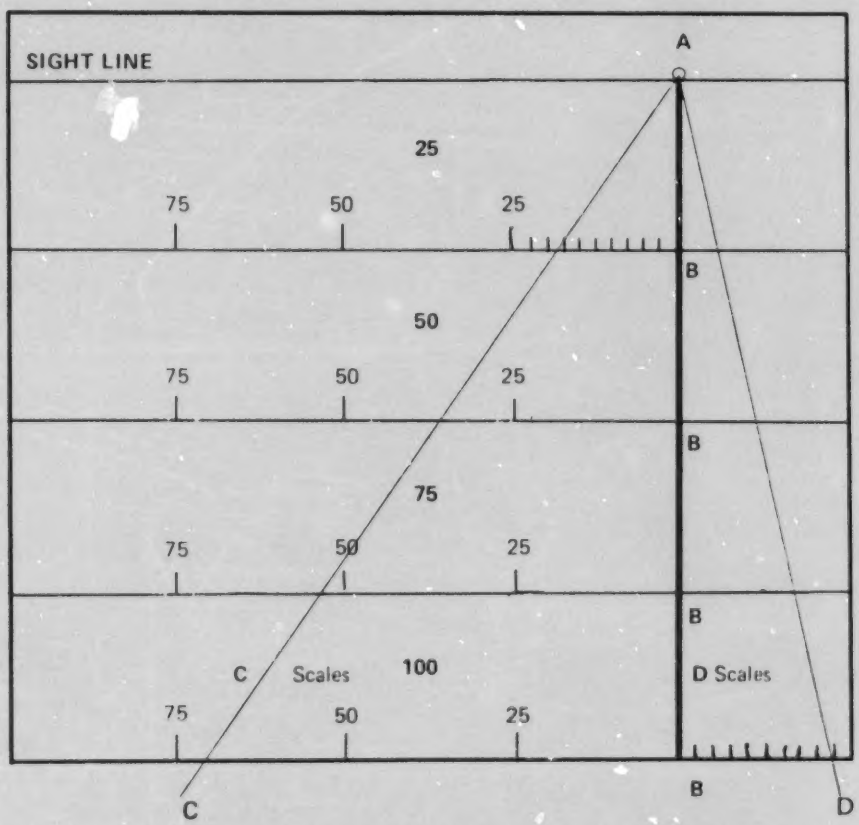
d) Suunto and Haga Hypsometers

In addition to the Abney level there are other instruments for making tree height measurements such as the Haga and the Suunto. With the Haga you set the scale, sight the pistol-like device on the tree and press a trigger which fixes the height reading in place until it is released.

The Suunto is a compact unit easily carried in a pocket. With it you

- Stand either 15 or 20 metres from the tree.
- Read values on the corresponding scale inside (20 m scale on left, 15 m scale on right).
- Sight at the top of tree with both eyes open.
- As soon as the hairline in the instrument coincides with the top of the tree the height can be read from the appropriate scale.
- As in the case of the Abney and Haga it is necessary to make separate readings to the top and bottom of the tree and add or subtract to get the proper total height measurement.

CARDBOARD HYPSOMETER



Make a cardboard hypsometer. Hang a weighted thread through a hole at A. Sight the top of the tree along the sight line. Press the thread to hold it in place. Read the tree height off the scale. Lines AC and AD represent threads. Use the 25 scale at 25 feet or metres from the tree, 50 at 50 feet or metres and so on at 75 and 100.

TREE HEIGHTS
BY 4 METHODS
(outdoor exercise)

Name _____
Class _____ Date _____

Equipment: Steel tapes, Abney levels, Suunto hypsometers, pencils, metre sticks, small rulers, clip boards.

Instructions: Use the same tree or pole for all four measurements. Each student is to turn in a report.

Measurements:

1) Abney level

- Distance to tree = _____ m
- Angle to top of tree = _____ degrees
- Angle to base of tree = _____ degrees

OR ..... Distance on tree from eye level to base _____ m

Using trig. tables, **calculate** the **tree height**: _____ m

2) Pencil method

Based on the distance the person acting as "marker" is from the tree, measured with a tape:

Height = _____ m

3) Multiplying a known height (eg. 2 m)

With zero on the ruler in line with the base of the tree and 2 cm on the ruler in line with 2 m up from the base of the tree, the ruler reading for the sighting line to the top of the tree gives the height.

Height = _____ m

4) Suunto hypsometer – – Using the **15 m** scale **and** distance.

Meter reading to the top of the tree = _____ m

Meter reading to the base of the tree = _____ m

Total for **tree height** = _____ m

Questions: How accurate is each measurement?
How do the four measurements compare?

Instruction Sheet 12
OFA Forestry Manual

2.6 TIMBER ESTIMATING
(Cruising)

We have been studying tree measurements. Now we will look at the measurement of groups of trees on areas of various sizes.

Estimating the volume of wood in standing forests is termed "**cruising**". It probably originated with the old timber cruiser who walked the bush and estimated the wood volume there on the basis of his experience. He walked only a portion of the forest so saw only a **sample** of the whole area. In cruising only a part of the forest is measured and the stand volumes obtained from the survey are applied to the whole area.

To determine the wood volume present in an area three possibilities exist:

i) Make a **guess** – not too reliable
ii) **Measure every tree** – accurate but expensive and time consuming
iii) **Sample** the forest – this will be less expensive and time-consuming and reasonably accurate. The sample area needs to be representative of the whole forest.

Sampling Example

If one-tenth of a two hundred and fifty hectare stand of trees is measured (ie. 25 hectares) and the sample volume is two thousand cubic meters or eighty cubic metres per hectare (2000 ÷ 25 = 80) then the **total volume** for the stand would be calculated as follows:

$$250 \times 80\,^3\text{m/ha} = 20{,}000\,^3\text{m}$$

Use of Cruise Data

The stand volumes obtained from timber estimating may be used for different purposes such as:

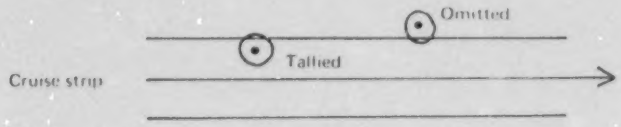
i) Long range planning – an **inventory cruise** based on a small percent sample is adequate.
ii) Logging operations – an **operational cruise** based on a small but larger percent sample is required.
iii) Timber sales
iv) Cutting licence negotiations

Four Cruising Methods

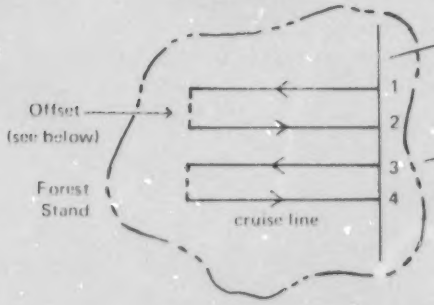
a) Strip
b) Plot
c) Point sampling with wedge prisms
d) Satellite/Computer

a) Strip Cruising

With **strip cruising** the diameters at breast height (dbh) of all trees within a certain distance of a centreline are tallied and the volume of wood on the area sampled and then on the total area of the forest stand are calculated from these diameter measurements. The line is usually centred upon a steel measuring tape that is dragged along the ground by a 'compassman' walking in a known direction (compass bearing). The length of the line is measured with the tape. The width of the strip on both sides of the line may be measured with a stick of chosen length, by known arms widths, by measuring tape or by pacing. The average number of paces taken by a person in a particular distance (say 20 metres) can be determined and used as a basis of field measurements. A tree on the edge of the strip is tallied if it is more than half on the strip; omitted if it is more than half off the strip.



Typical Strip Cruise Set-up

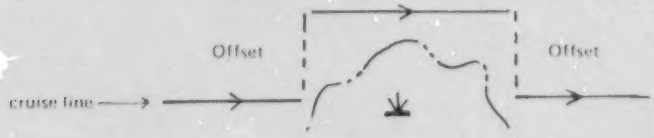


Base line: a reference line from which cruise lines are run. A township line, survey line, etc.. No tally.

Station (no. 3) on the base line. A tie-in point for the cruise line.

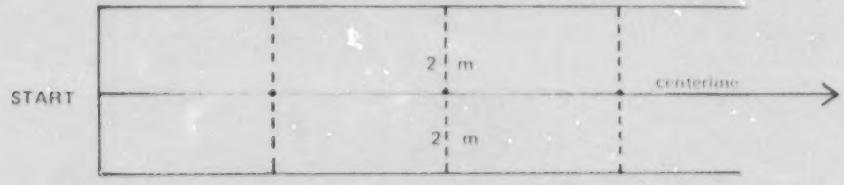
Cruise line: tree diameters measured and tallied for a certain distance along both sides of the centreline.

Offsets are used to change the direction of a cruise line or to avoid a major obstacle such as a swamp. No tally is taken with an offset.



ACTIVITY –

In groups of three run a 4 metre wide cruise strip for 50 or more metres through a stand of trees. See Strip Cruise Tally Sheet on page 47 for crew make-up and related duties. Each person is to play each role and each is to submit a completed tally for compilation in the crew's total results.



STRIP CRUISE TALLY SHEET

Cruiser's Name _____
Class _____ Date _____

(Everyone is to turn in a completed strip cruise tally sheet)

Compassman _____

See Crew Duties on back of page

Caliperman _____

Diameter Class (read measurement to next lower number to record)	Species (Tally ⊠ = 10)							
	Pj	Pw	Sw	Po				
12 cm								
14								
16								
18								
20								
22								
24								
26								
28								
30								
32								
34								
36								
38								
40								
42								
44								
46								
48								
50								
52								
54								
56								
58								
60								
Totals								

DUTIES OF CREW MEMBERS

Compassman
- attaches chain to his/her belt.
- from the starting point, using a compass bearing, sights on some distant object and moves in as straight a line as possible towards it.
- when the cruiser yells "chain" at the end of the moving tape, the compassman stops and waits for the tallying to be completed for that section.
- then the procedure is repeated.

Caliperman
- measures the Dbh of all the trees within the strip over a certain diameter.
- calls out the species and diameters for the cruiser to tally. (eg. red pine 18).
- carries a measure to check strip width.

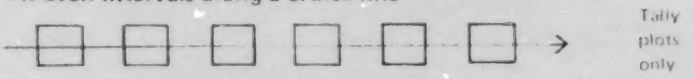
Cruiser
- the crew boss.
- stops the compassman when the chain has run out by yelling "chain".
- tallies the species and diameter as the caliperman calls out the information.
- calls back the species and diameter to show the caliperman that he/she heard correctly.

b) Plot Cruising

Cruise plots vary in shape and size. They may be **square, rectangular** or **circular**. For convenience they should represent a **decimal fraction** of a hectare in size for easy compilation of totals.

Cruise plots may be **located in two ways**

- At **even intervals** along a cruise line



- **Random plots** in a forest type – located at random in the stand,not the best parts – should produce an "average" if done correctly.

Application of Data

As with the strip cruising and other forms of sampling in the woods, the data produces a volume per unit area (m^3/ha) that is then applied to the whole area for a volume total.

The use of **aerial photographs** has greatly decreased the amount of cruising required on the ground. **Photo interpretation** makes it possible to estimate timber volumes with varying degrees of accuracy while at the office. Forest type boundaries and cruise locations can be established on the photographs.

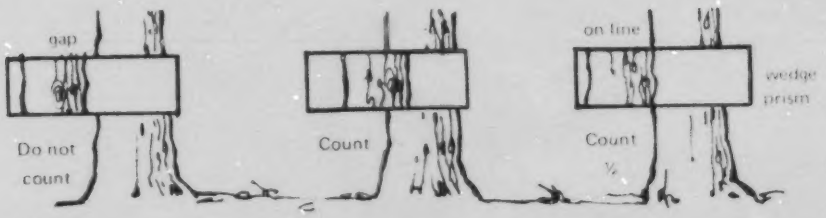
From Diameters to Volumes

The measurements obtained from a cruise are converted to tree volumes through the use of tables. A variety of these is available though tables prepared locally are most reliable as trees tend to be similar in shape in certain areas. A small section from a **Cubic Metre Rule (m^3)** shows volumes in cubic metres:

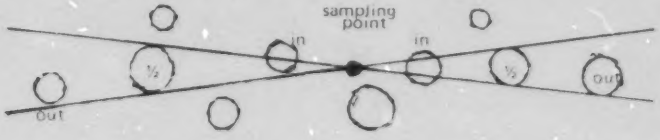
Diam (cm)	Log Length (metres)			
	13.7	13.9	14.1	14.3
10	0.108	0.109	0.111	0.112
12	0.155	0.157	0.159	0.162

c) Point Sampling With Wedge Prisms

The **wedge prism** is a thin wedge of glass that bends light rays. When a tree is viewed both through and over the prism at the same time the result is a split image.



The prism is held over a **sampling point** and a **tree count** is made through a 360° horizontal sweep. Tree diameters are not measured. All trees are counted that are not cut completely in two when viewed through the prism. Borderline trees count for one-half. There is **no plot boundary.** As trees get further from the sampling point their split image separates further and at some point they are too far away to tally. "In" or "Out" depends on a combination of diameter and distance. **When a slope exists** the prism should be tilted so that it is at right angles with the ground. When another tree gets in the way the prism is moved to one side but no nearer to the tree being sighted.



Each prism is marked with a **factor** by which the number of trees counted within the sweep is multiplied to provide the **basal area per hectare** (A common factor with metric prisms is 2.)

Basal area is the cross-section area of an individu ee or of all the trees on one hectare at breast height (1.3 m). The basal area of o ree is calculated in the same way that the area of a circle is found, ie. Area = πr^2.

eg. Basal area of 30 cm tree = $\frac{22}{7} \times \frac{15}{100} \times \frac{15}{100}$ = .0706 square metres

A southern Ontario forest with a basal area of 18.5 sq.m./ha is considered to be in optimum growing condition. As the basal area rises it is desirable to harvest some trees to bring the basal area back to 18.5.

This point sampling method of measuring standing timber is fast, simple and relatively inexpensive. It does not require the location of plot boundaries. The information it provides is in terms of basal area and so may be more limited (though adequate) than other cruise systems. It is particularly useful, however, in providing information on how much to thin a stand to improve its growth.

d) Satellite-Computer Timber Estimates

This is an offshoot of satellite technology which is currently used in broadcasting television events "live" around the world. It is also part of the sophisticated spying systems of the super-powers. **Its use in forestry is still largely experimental** but the possibilities are immense. The satellites involved orbit the earth at about 160 km and provide information on any point on earth at intervals of 18 days.

Signals received from the satellite provide a series of numbers that represent different degrees of darkness and light. **Colour coding** is applied giving a picture of the desired information. Data on areas as small as **9 metres square** is available.

With the Ministry of Natural Resources satellite information is interpreted at the Remote Sensing Unit in Toronto. Transparent prints are handled by a machine which provides a **density scan** that results in a **colours translation**. This coloured picture is projected onto a tv monitor and known features such as water, standing timber and cutover areas can be identified. Tree species with definite differences can also be located.

The **computer** involved has to be "trained". Locations representing a certain condition are given a colour. It is then programmed to scan the area and to identify all the parts ("pixels") which are the same. The result is a "type" or "stand" map.

(It may be possible to obtain satellite photo sets to show students.)

Low level infra-red photography has other uses than timber estimating but mention of it here seems appropriate. MNR's Remote Sensing Centre in Toronto is also involved in infra-red photography. It is used in fire detection, regeneration surveys, location of cutover areas, burns, etc. The equipment used is very sensitive to heat. For example, a burning cigarette can register its presence at a considerable distance and an airport runway shows up distinctly because it reflects a different heat intensity than the surrounding ground.

2.7 SCALING

Scaling is the measurement of forest products – such as pulpwood and sawlogs – after the trees have been cut down. (Cruising, remember, is the measurement of standing timber.)

a) Uses of Scaling

Over 80% of the forest land in Canada is **crown land** meaning that it is public land managed by the provincial government. In Ontario this is done by the Ministry of Natural Resources (MNR). Wood cut on crown land is scaled and the person or company which cut the wood is charged "dues" on the basis of so much per cubic metre or other unit of measure. Scaling is used:

- to pay loggers working on a "piecework" (contract) basis
- to obtain production figures
- to pay the provincial government "dues" or stumpage for wood cut on crown land in the sale of logs and pulpwood

b) Tree Symbols

Tree symbols used by MNR on scale sheets, maps, reports, etc. are standardized as follows:

i) Use a **capital letter** when there is only one letter and with the first letter when there are two.

ii) Use a **second (small) letter** when showing the species or when there are two or more symbols starting with the same letter.

Remember that a **genus** is a collection of closely related species and the species a collection of individuals of like character.

eg. white pine (Pw) – pine is the genus, white the species identification.

The following symbols are common:

pine (ALL)	–	P	spruce (ALL)	–	S
white pine	–	Pw	white spruce	–	Sw
red pine	–	Pr	black spruce	–	Sb
jack pine	–	Pj			
Scots pine	–	Ps			

hemlock	–	He (H alone would be hardwood)
balsam	–	B
cedar	–	Ce (C alone would be conifers)
conifers (ALL)	–	C

maples	– M	poplars	– Po
yellow birch	– By		
white birch	– Bw	hardwoods (ALL)	– H

c) Scaling Methods

Forestry practices in Ontario, including scaling, are converting to the metric system but there are still many using imperial units. Students may need to be aware of these so the following includes a mixture of the old and new.

Scaling methods include:

i) Stacked Wood (metric and imperial)
ii) Cubic Measure
iii) Board Foot Measure (Ontario Rule)
iv) Hardwood Log Grading
v) Tree Length Scaling
vi) Mass Scaling (weighing)

i) Stacked Wood

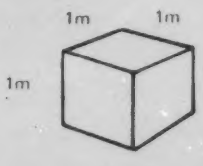
Stacked wood is the total amount of **wood, bark and air space** contained in a stack of roundwood as determined by its external dimensions. It may be measured in **cubic metres** (m^3) or **cords**. The stacked cubic metre is replacing the cord as a unit of measurement.

The **volume of a pile of wood** is obtained by multiplying its height x length x width.

$$VOL = H \times L \times W$$

Stacked Cubic Metre

One **stacked cubic metre** is a stack of roundwood (logs) one metre in length, one metre in height and one metre in width.



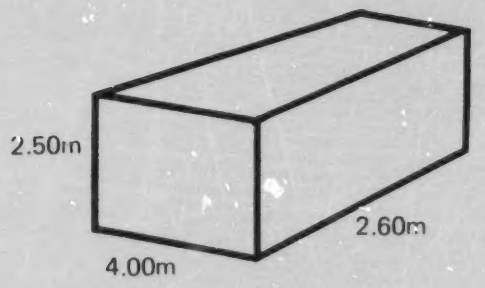
Volumes in stacked cubic metres are calculated to two decimal places on the basis of H x L x W where:

H = height in metres and 2 centimetre classes
L = length in metres and 2 centimetre classes
W = width in metres and 2 centimetre classes

eg. 1.50 metres = 1 m and 50 cm
1.52 metres = 1 m and 52 cm

When a dimension comes between the class boundaries READ DOWN for the value to be tallied. A measurement between 1.50 and 1.52 should be tallied as 1.50 m.

Sample Problem



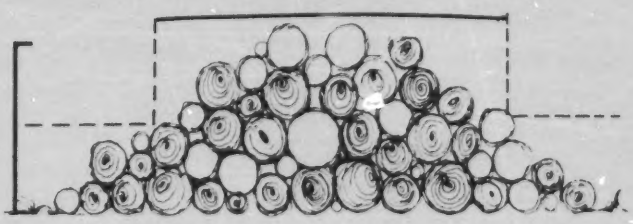
VOLUME = H x L x W

= 2.50 x 4.00 x 2.60

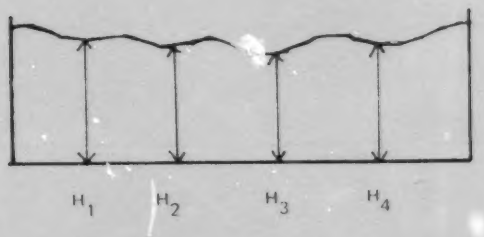
= 26.00 m^3

Adjustments for Irregular Dimensions

Not all woodpiles are even.



When a pile slopes at one or both ends the **length** measurement should be taken between the points at which half the height of the pile intersects the line of the slope.



A stack with irregular height is best measured by a series of height measurements at even intervals at **right angles to the ground** and the **average height** determined from these.

Stacked Cords

1. The **Standard Cord** is the old method of measuring stacked wood. Since it is still a familiar unit it is covered here. Understand the difference between it and the short (or stove) cord.

   A typical cord measures 4 feet high by 8 feet long by 4 feet wide (which is stick length). Stacked cords usually contain 4-ft. or 8-ft. logs and the width of the pile used in the calculation varies accordingly.

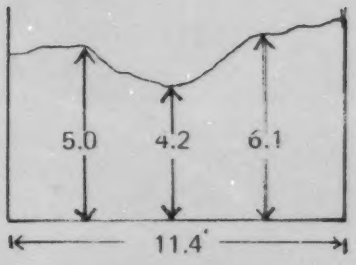
   $$H \times L \times W = 4 \times 8 \times 4 = \textbf{128 cubic feet.}$$

   To find the number of cords in a pile the outside dimensions are divided by 128.

   $$\frac{H \times L \times W}{128} = \_\_\_\_\_ \text{ cords}$$

Examples

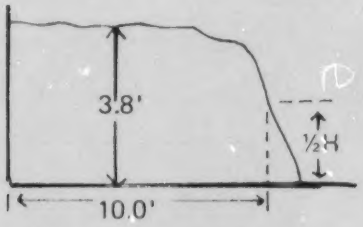
(1) 4-foot wood



$$\text{avg. ht.} = \frac{5.0' + 4.2' + 6.1'}{3} = \frac{15.3'}{3} = 5.1'$$

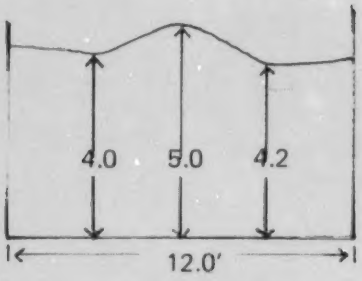
$$\text{Vol.} = \frac{5.1' \times 11.4' \times 4.0'}{128} = 1.81 \text{ cords}$$

(2) 4-foot wood



$$\frac{\text{Vol.} = 3.8' \times 10' \times 4.0'}{128} = 1.19 \text{ cords}$$

(3) 8-foot wood



$$\frac{\text{avg. ht.} = 4.0' + 5.0' + 4.2'}{3} = 4.4'$$

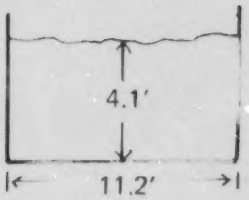
$$\frac{\text{Vol.} = 4.4' \times 12' \times 8.0'}{128} = 3.3 \text{ cords}$$

2. **Short, stove or face cords** are terms often used with fuelwood. They contain roughly one-third the volume of a standard cord but will vary depending upon the length of the sticks. These may be from 10-18 inches though the original definition may have called for 16 inch sticks. Due to this stick length variation the public is advised to avoid use of the face cord or short cord and deal in standard cords or fractions thereof.

   To find the number of short cords (when dealing with 16 inch sticks) multiply the length of the pile x height of the pile and divide by 32.

$$\frac{H \times L}{32} = \_\_\_\_\_ \text{ cords}$$

Example



16 inch wood
area of front surface (face area)

$= 11.2' \times 4.1'$

$= 45.92$ sq. feet

$$\text{Vol.} = \frac{45.92}{32} = 1.43 \text{ short cords}$$

(Be wary of the length of sticks and think in terms of standard cords for most purposes or, better still, stacked cubic metres.)

ii) **Cubic Measure**

Cubic measure ("cubing") gives the **solid wood volume** based on the measurement of individual logs. Do not confuse it with **stacked** cubic measure.

The old method of cubic measure used cubic feet and 100 cubic feet of solid wood equalled **1 cunit**. A cord contains 128 cubic feet of wood, bark and air space. About 85 cubic feet of solid wood is found in a cord.

Volume in Cubic Metres

$$Vm^3 = \frac{D\ cms^2 \times 0.7854 \times Lm}{10{,}000}$$

D = diameter of piece or defect in 2 cm. classes

L = length of piece in metres and 20 cm. classes

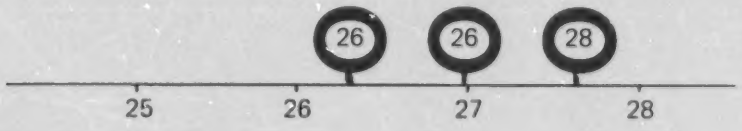
Students may be interested in determining the basis for the cubic metre formula above. The area of the circle in square centimetres is divided by 10,000 to convert it to square metres.

$$Vm^3 = \frac{3.1416 \times \frac{Dcm}{2} \times \frac{Dcm}{2} \times Lm}{10{,}000} = \frac{Dcm^2 \times 0.7854 \times Lm}{10{,}000}$$

Diameters are measured **inside the bark** to provide for the **solid wood volume** and from one side of the pile only to average large and small ends of logs.

The **class boundary** occurs on the odd centimetre. When the measure coincides with the class boundary the lower even numbered size class is tallied. Put another way: on or below an odd centimetre read down to the nearest even centimetre. Over the odd centimetre read up to the next even centimetre. Only even numbers are tallied, not odd numbers.

eg.



Recall that in **cruising** the diameters were measured in 2 centimetre classes **down** to the lower even number.

Lengths are measured in metres and 20 cm classes resulting in lengths such as 2.9 m, 3.1 m, 3.3 m, etc.

Volume tables are usually used to obtain the volumes for logs of various dimensions. See Volume Table page 59

Deductions For Defects

Diameters of defects can be measured in the same way as gross diameters and the defect volumes subtracted from the gross volumes to give the net volumes of sound wood. More commonly, however, "diameter reduction for interior defects tables" are used. (See page 59.)

Examples

Using the two tables on page 59 :-

	Using tables
a) Log length 5.3 m Log diameter 56 cm Diam. of defect 22 cm	Reduction = 4 cm Net diam. = 56 – 4 = 52 cm Net vol. of 5.3 m log x 52 cm = **1.126 m^3**
b) Log length 4.9 m Log diameter 60 cm Diam of defect 10 cm	Reduction = No deduction Net diam. = 60 – 0 = 60 cm Net vol. of 4.9 m log x 60 cm = **1.385 m^3**
c) Log length 6.1 m Log diameter 44 cm Diam. of defect 36 cm	A CULL log (not tallied) No volume

Cubic Metre Scale Sheet

It may be possible to actually scale some logs or a substitute such as different sized circles on a blackboard. Metre sticks will do as scale sticks. Tables from a scaling manual are needed. Students can make up their own tally sheets based on the following:

Diam. (inside bark)	Number of sticks (Tally)	No.	Vol/Stick	Total Vol (m^3)
52	𝍸	8	0.998	7.984
54	𝍸 :	13	1.076	13.988
56	𝍸	9	1.158	10.422
58	𝍸	7	1.242	8.694
60	𝍸 ·	11	1.329	14.619
Total				55.707 m^3

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VOLUME TABLE

Volume in Cubic Metres for Diameter in Centimetres and Length in Metres

Diam.	Length 4.7	4.9	5.1	5.3	5.5	5.7	5.9	6.1	6.3
50.	0.923	0.962	1.001	1.041	1.080	1.119	1.158	1.198	1.237
52.	0.998	1.041	1.083	1.126	1.168	1.211	1.253	1.295	1.338
54.	1.076	1.122	1.168	1.214	1.260	1.305	1.351	1.397	1.443
56.	1.158	1.207	1.256	1.305	1.355	1.404	1.453	1.502	1.552
58.	1.242	1.295	1.347	1.400	1.453	1.506	1.559	1.612	1.665
60.	1.329	1.385	1.442	1.499	1.555	1.612	1.668	1.725	1.781
62.	1.419	1.479	1.540	1.600	1.660	1.721	1.781	1.842	1.902
64.	1.512	1.576	1.641	1.705	1.769	1.834	1.898	1.962	2.027
66.	1.608	1.676	1.745	1.813	1.882	1.950	2.019	2.087	2.155
68.	1.707	1.780	1.852	1.925	1.997	2.070	2.143	2.215	2.288
70.	1.809	1.886	1.963	2.040	2.117	2.194	2.271	2.348	2.425
72.	1.914	1.995	2.076	2.158	2.239	2.231	2.402	2.484	2.565
74.	2.021	2.107	2.193	2.279	2.365	2.451	2.537	2.624	2.710
76.	2.132	2.223	2.314	2.404	2.495	2.586	2.677	2.767	2.858

DIAMETER REDUCTIONS FOR INTERIOR DEFECTS IN CUBIC MEASUREMENT

Log Diam	Defect Diameter 4	6	8	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42	44	46	48	50	52	54	56	58	60
6																													
8	2																												
10		2																											
12		2	2																										
14		2	2																										
16		2	2	4																									
18		2	2	4	4																								
20			2	2	4	4																							
22			2	2	4	6																							
24			2	2	4	4	6																						
26			2	2	2	4	4	6																					
28			2	2	2	4	4	6																					
30			2	2	2	4	4	6	8																				
32			2	2	2	4	4	6	8	8																			
34	N			2	2	4	4	6	6	8	8																		
36	O			2	2	2	4	4	6	8	10																		
38				2	2	2	4	4	6	8	8	10																	
40	D			2	2	2	4	4	6	6	8	10	10																
42	E			2	2	2	4	4	6	6	8	10	10																
44	D			2	2	2	4	4	4	6	8	8	10	12															
46	U			2	2	2	2	4	4	6	6	8	10	12	12														
48	C			2	2	2	2	4	4	6	6	8	10	10	12														
50	T			2	2	2	2	4	4	6	6	8	8	10	12	14													
52	I				2	2	2	4	4	4	6	6	8	10	12	12	14												
54	O				2	2	2	4	4	4	6	6	8	10	10	12	14	14											
56	N				2	2	2	2	4	4	6	6	8	8	10	12	14	14											
58	S				2	2	2	2	4	4	6	6	8	8	10	12	12	14	16										
60					2	2	2	2	4	4	6	6	6	8	10	10	12	14	16	16									
62					2	2	2	2	4	4	4	6	6	8	8	10	12	14	14	16									
64					2	2	2	2	4	4	4	6	6	8	8	10	12	12	14	16	18								
66					2	2	2	2	4	4	4	6	6	8	8	10	10	12	14	16	16	18							
68					2	2	2	2	4	4	4	6	6	6	8	10	10	12	14	14	16	18	18						
70					2	2	2	2	4	4	4	6	6	6	8	8	10	12	12	14	16	18	20						
72					2	2	2	2	2	4	4	4	6	6	8	8	10	10	12	14	16	16	18	20					
74						2	2	2	2	4	4	4	6	6	8	8	10	10	12	14	14	16	18	20	20				
76						2	2	2	2	4	4	4	6	6	8	8	10	10	12	12	14	16	18	18	20				
78						2	2	2	2	4	4	4	6	6	6	8	8	10	12	12	14	16	16	18	20	22			
80						2	2	2	2	4	4	4	6	6	6	8	8	10	10	12	14	14	16	18	20	20			
82						2	2	2	2	4	4	4	4	6	6	8	8	10	10	12	12	14	16	18	18	20	22		
84						2	2	2	2	2	4	4	4	6	6	8	8	10	10	12	12	14	16	16	18	20	22	22	
86						2	2	2	2	2	4	4	4	6	6	8	8	8	10	10	12	14	14	16	18	20	22	22	22

CULL

iii) **Board Foot Measure, Ontario Rule**

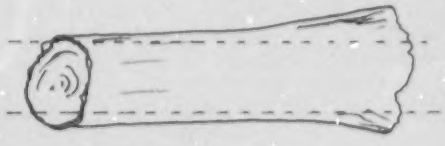
All hardwood material from Crown lands in Ontario except poplar and white birch, up to and including 18 feet 8 inches, has been measured in **board feet** by the **Ontario Log Rule**. Material over this length is measured in cubic feet. Hardwood of grade 3 quality may be stacked and weighed. (See v)

A typical **board foot** of lumber is 12" x 12" x 1".

The Ontario Log Rule is a standard table which fixes the content of logs in terms of **sawn lumber** on the **basis of log diameters and lengths**. Allowances have been made in its development for losses in the wood sawn from logs due to slabs, sawdust, planing, shrinkage and other factors. Some private operators use other log rules which provide different volume content estimates. Buyers and sellers of timber need to know the log rule being used and its possible effect upon revenues and costs.

Scaling sticks used by the scaler are like metre sticks with a handle at one end and a plate at the other. Board foot volumes based on the Ontario Log Rule for wood sixteen feet long are marked on the scaling stick for each diameter class. (Percentage deductions in inches for exterior defects are marked for diameters from 4 to 30 inches.)

Logs are measured at the small (top) end since the diameter here sets the limits on what can be sawn from the log as lumber.



This type of scaling requires two men (a head scaler and an assistant) working at the opposite ends of the logs on a skidway (pile). Each log has to be identified and the diameter of the top (smaller) end tallied. After the logs have been measured the head scaler marks the ends with a black crayon. The assistant stamps each log with an "S" using a scaling hammer.

Deductions for defects are very complex and will not be dealt with in detail. Very briefly:

- Interior defects – deductions made on a volume basis
- Exterior defects – deductions on a percentage basis
- Culls – logs in which over 2/3 of the board foot volume is defective. (Not tallied.)

Ontario Rule Formula, the basis for the Ontario Rule board foot volume tables is:

$$(0.55\ D^2 - 1.2D)\frac{L}{12}$$

D = top (small end) diameter in inches
L = length of the log in feet

For an explanation of the development of this formula see the Ontario Manual of Scaling Instruction.

iv) **Hardwood Log Grading**

Hardwood logs, except poplar and birch, are scaled in board feet and recorded in **one of three log grades**. These grades are based upon three factors: top end diameter, log position in the tree (butt logs or uppers) and the total amount of contained defect.

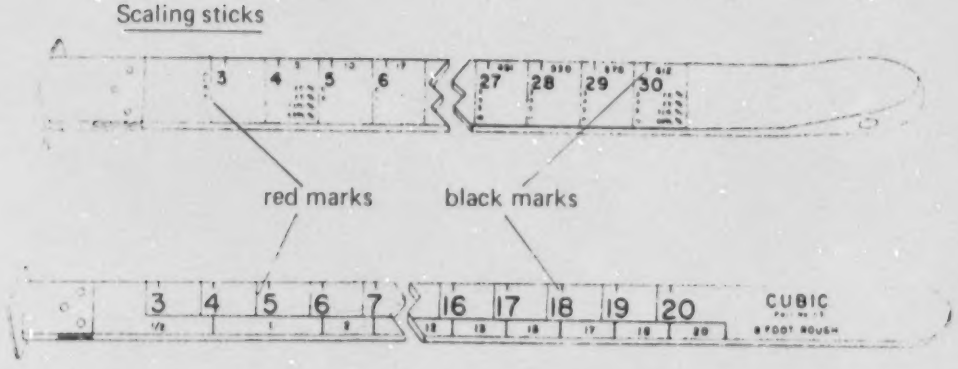
Grade 1 – best **Grade 2** – medium **Grade 3** – poor

v) **Tree Length Scaling**

This method is used for those mechanical cutting operations where trees are cut, skidded and piled in tree length form. Scaling may be **in cubic metres or mass (weigh) scaled. Butt diameters**, by tree species, are measured inside bark in 2 cm. classes. Volume data from measured sample trees is then used for a calculation of the volume for the total number of trees on a particular operation or group of operations.

vi) **Mass Scaling (Weighing)**

This is the simplest and most precise method of scaling but it requires the installation of expensive weighing equipment. Conifers, poplar and white birch, grade 3 hardwoods and fuelwood may be mass scaled. The **gross mass** in kilograms of a loaded vehicle is obtained. The **tare mass** (empty weight) of the vehicle is deducted giving the **net mass** of the wood. A percentage deduction is made for bark.



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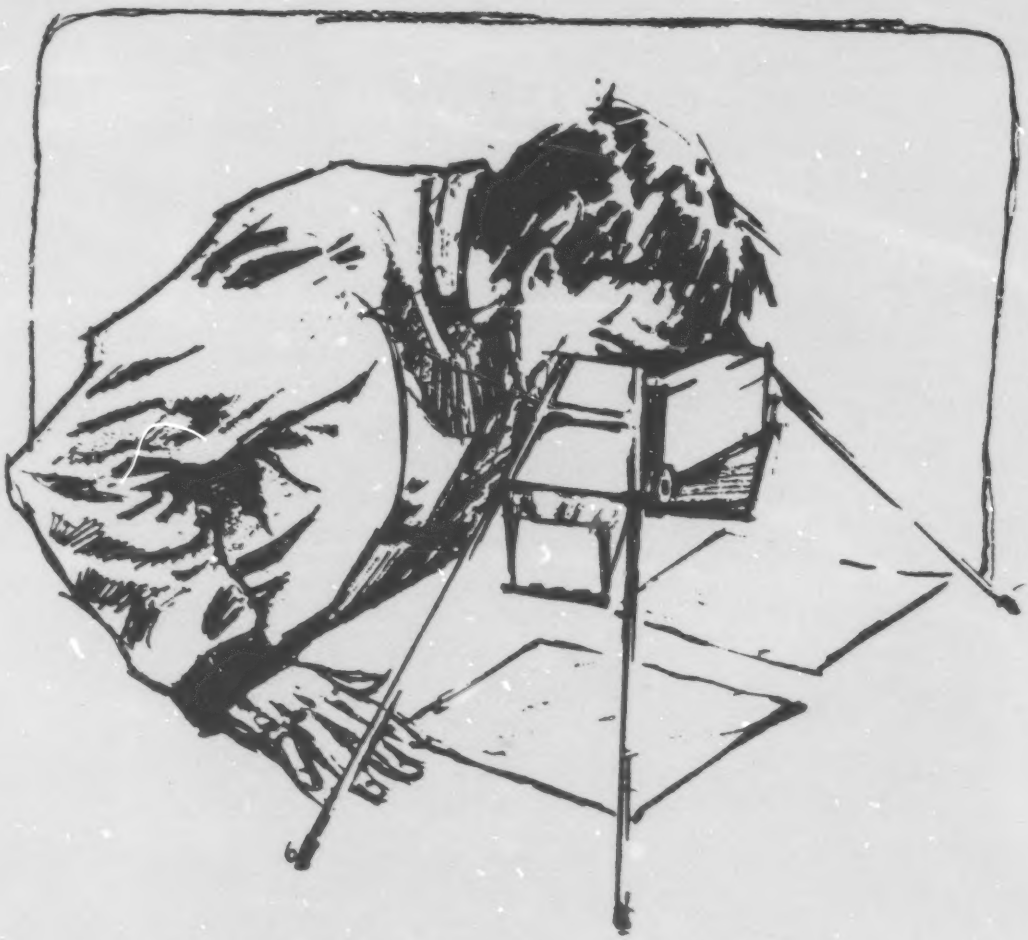
d) Scaling Summary

Method	Volumes and Units	Other Details
(1) **Stacked Wood** (wood, bark, & air)	(a) **cords** – 128 cu. ft. (see also "short cords) (b) **cubic metre** – stacked	Typical cord 4' x 8' x 4' Scaled on **one side** of pile. 1 m x 1 m x 1 m = 1 m^3 Scaled on **one side** of pile.
(2) **Cubic Measure** ("Cube scaling") Solid wood volume	(a) **cubic foot** (b) **cubic metre**	1' x 1' x1' 100 cu. ft. - **1 cunit** 1 m x 1 m x 1 m = 1 m^3 Scaled on **one side** of pile. (Butt and top diameters average out.)
(3) **Board Foot Measure, Ontario Rule**	**Board foot units**	**Tables** provide conversions from log diameters to board foot values for the different lengths.
(4) **Hardwood Log Grading**	**Board feet** (Ont. Rule)	**3 grades**: Gr. 1 (best) Gr. 2 (medium) Gr. 3 (poor)
(5) **Tree Length**	(a) cubic metres or (b) kilograms (mass)	**Butt diameters** recorded by species.
(6) Mass (weighing)	kilograms (kg)	Mass of loaded vehicle, minus mass of empty vehicle (tare weight) gives the net weight of wood... A % deduction for bark.

Note: **Cubic feet** -- cu. ft. -- c.f.
Board feet -- bd. ft. -- fbm (foot board measure)
-- B.M. (board measure)

Marking Scaled Wood: Depending on what is being measured, scaled wood is shown with an "S" applied with a black marking crayon or stamped with a scaling hammer, or both. Cull logs are marked with "Cull".

UNIT 3
MAPS & AERIAL PHOTOGRAPHY



UNIT 3: MAPS & AERIAL PHOTOGRAPHY

OBJECTIVE

In this unit students will be introduced to maps and aerial photography and the importance of magnetic and true north.

3.1 TYPES OF MAPS USED IN FORESTRY

Though road, weather, demographic, and other types of maps have uses – for forestry the main maps of interest are

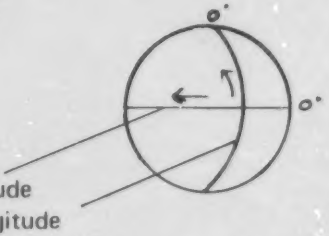
i) base maps
ii) topographic/relief/contour
iii) soil type
iv) forest stand ("type") maps

a) Base Maps

Base maps show the main land and cultural (man-made) features. Forestry information is often added to base maps. If "forest types" are added, it then becomes a forest stand map. The base map scale has been 4 inches to one mile and aerial photographs run at roughly the same scale. Now a common scale for base maps uses a representative fraction of 1:20 000. (More on this later).

Number Identification of MNR Base Maps

The numbers are based on latitudes and longitudes. Each square within one degree of latitude and longitude contains 32 map sheets, four across and eight up.



With the **6-figure map numbers:**

1st 3 = latitude
2nd 3 = longitude

		491803			49° lat.
				488801	
				487801	Rule of Thumb:
	486804			486801	1st – UP NORTH
485811				485801	2nd – GO WEST
	484804	484803		484801	eg. 485 801 = 485801
				483801	483794
				482801	
	481804	481803	481802	481801	48° lat.
81°	long.			80°	long.

starting point for indexing:
The SOUTH–EAST

It should be noted that the Ontario Basic Mapping program now underway is providing new maps for Ontario. For further information contact Ontario Basic Mapping, Ministry of Natural Resources, Queen's Park, Toronto, M7A 1W3.

b) Topographic Maps

Topographic maps are also known as top, topo, relief and contour maps.

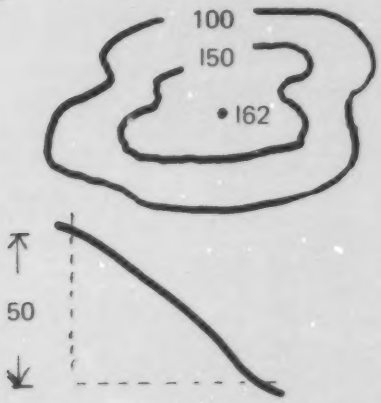
Contour lines – follow one elevation on the ground.

Contour intervals – the vertical distance between adjacent contour lines.

Spot height – a surveyed elevation shown on a map by a dot and number. eg. . 579
(spot above sea level)

Elevations - height above sea level.

eg.



spot height – 162

contour lines – at elevations of 100 & 150

What would be the significance of lines closer together and further apart?

contour interval – 50

Map Colours: contours – brown
water – blue
forests – green
cultural - black
roads and power lines - red

"Top" Map Forestry Uses:

- for locating roads, camps, etc.
- making decisions as to the best way to get wood moved out of an area.

In general, it is better if **cruise lines** cut across contour lines, in order to give a more "representative sample" of the forest in that area. If a cruise line ran parallel with the contour lines in a low area, for example, the tally might show mainly cedar while in actual fact cedar was only 5% of the total stand volume.

c) Soil Type Maps

Soil, the unconsolidated mineral material on the surface of the earth that serves as a natural medium for land plants, is an important feature in land management. It varies greatly in many respects depending upon the material from which it formed, how it arrived in its present location, the size of particles composing it, the effects of weather, its slope, stoniness, presence of organic matter and other factors. (See Soil Zone Map of Ontario on page 69).

Many questions arise concerning soil use:

- What land should be used for farm crops, trees, buildings or commercial development?
- Should development take place on the soils of the Niagara fruit belt?
- Should poor farms on marginal soils be converted to growing tree crops?

Different tree species grow better if the soil is right. What is good for one type of tree may be poor for another.

eg. jack pine frequently grows well on sand while poplar may be of poor quality on the same site.

Soil Textures Based on Particle Size:

Sand – has large particles (up to 2 mm) does not hold water nor form solid lumps

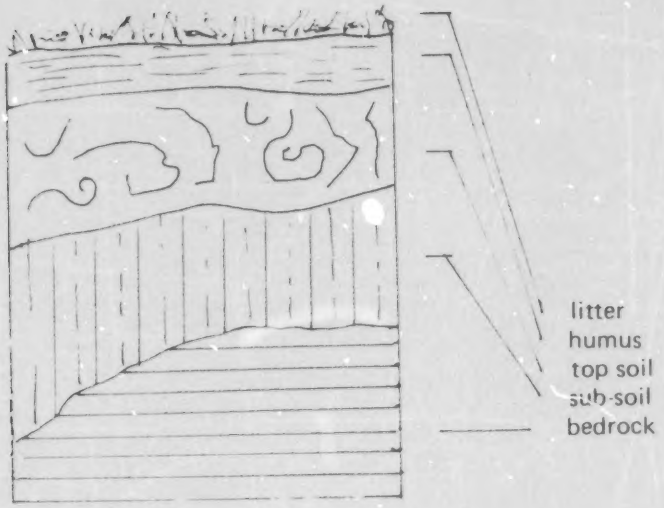
Silt – medium sized particles (0.002 – 0.02 mm), may clod but these break up easily when dry, when moistened it may squeeze between fingers to form a flat flake but will not ribbon like tooth paste.

Clay – very small particles (less than 0.002 mm) forms hard lumps when dry, usually plastic and sticky when wet and will ribbon .

Soil Profiles:

A soil profile gives a side-view or cross-section description of soil layers. It can be seen from core samples using a type of soil borer, from a soil pit wall or cut bank along a road, river, lake or pit.

Parts of a simple **soil profile** are as follows:



Litter – refers to the leaves, twigs, etc., that collect on top of the soil.

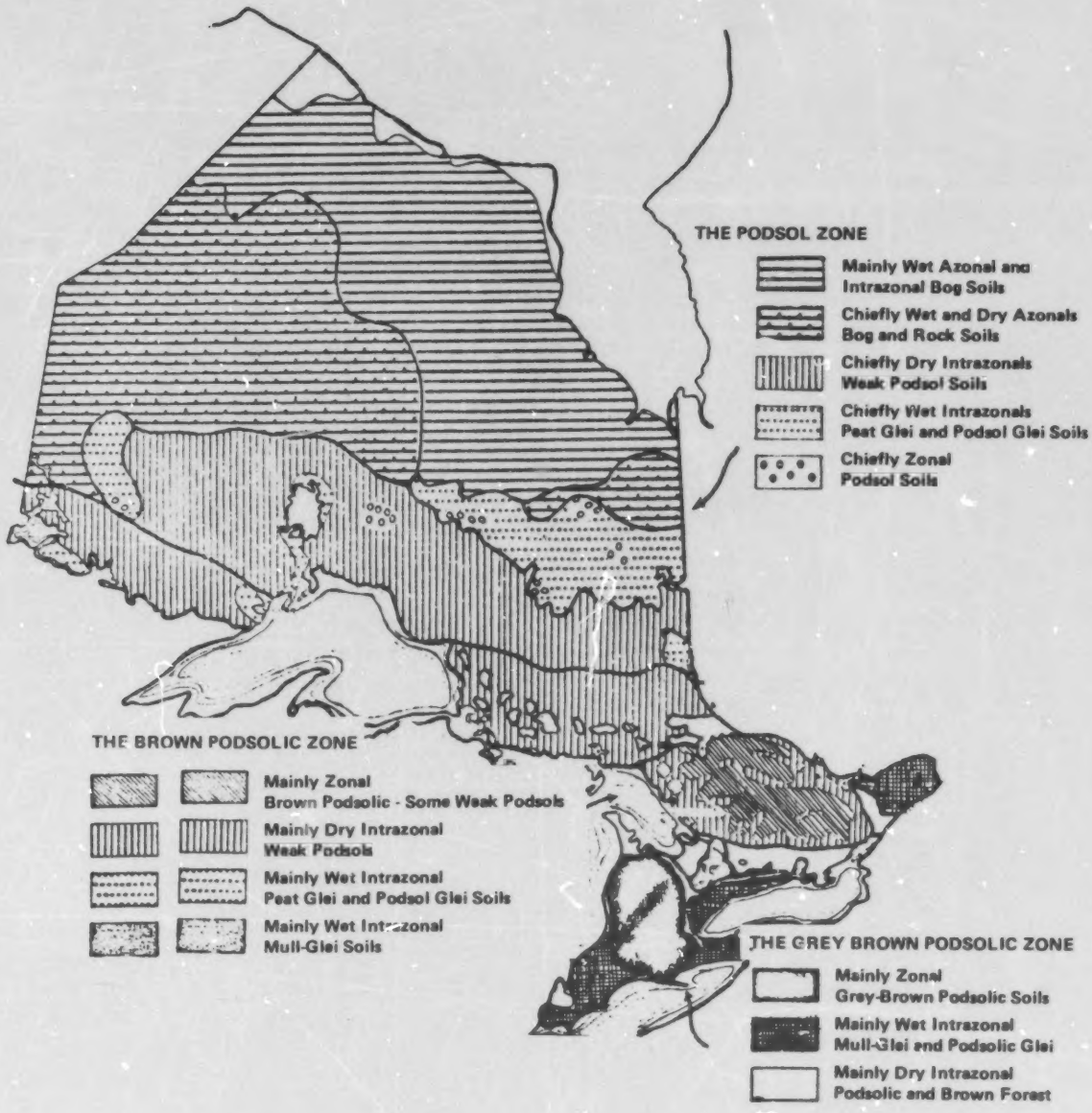
Humus – the decayed matter that mixes with the top soil. It fertilizes the soil and helps it retain moisture.

Top Soil – the better soil on top; includes humus material.

Sub-soil – infertile mineral soil underneath, without humus.

Bed-rock – the underlying, basic rock.

For further information on forest soils read "Forest Soils" by K. A. Armson, University of Toronto Press, 1977.


THE PODSOL ZONE
Mainly Wet Azonal and Intrazonal Bog Soils
Chiefly Wet and Dry Azonals Bog and Rock Soils
Chiefly Dry Intrazonals Weak Podsol Soils
Chiefly Wet Intrazonals Peat Glei and Podsol Glei Soils
Chiefly Zonal Podsol Soils
THE BROWN PODSOLIC ZONE
Mainly Zonal Brown Podsolic - Some Weak Podsols
Mainly Dry Intrazonal Weak Podsols
Mainly Wet Intrazonal Peat Glei and Podsol Glei Soils
Mainly Wet Intrazonal Mull-Glei Soils
THE GREY BROWN PODSOLIC ZONE
Mainly Zonal Grey-Brown Podsolic Soils
Mainly Wet Intrazonal Mull-Glei and Podsolic Glei
Mainly Dry Intrazonal Podsolic and Brown Forest

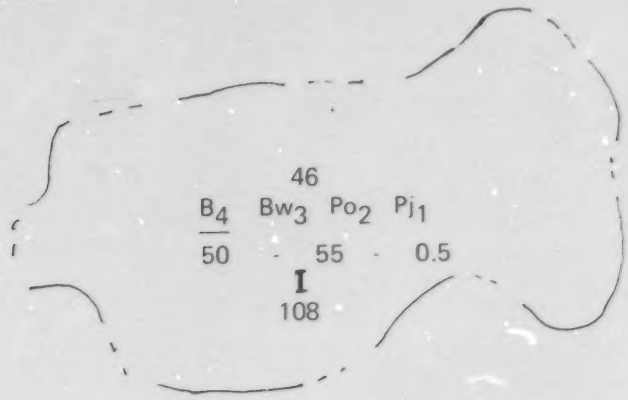
SOIL ZONE MAP OF ONTARIO

d) **Forest Stand (or "Type" Maps)**

A forest stand map shows the **location and description of forest stands**. This information is added to base maps. The details are usually transferred from aerial photographs with a stereoscopic device called a sketch master.

Stand or **type boundaries** are shown as broken lines separated by two dots.

The **type description** contains much information:



1st line
- Type number on map

2nd line
- Species composition and percentage
- 4 = 40% 3 = 30% Total 10 = 100%
- Major species first and underlined. It is called the "working group species"

3rd line
- Age
- Height
- Stocking (details follow)

4th line
- Site class number 1 – good 2 – medium 3 – poor

5th line
- Area

Other details shown on the map include:

D.A.L. – developed agricultural land
U.C.L. – unclassified land (towns, roads, etc.)
P.F. – protection forests – not available for cutting or subject to special management techniques – protect land from erosion, etc. A common example is sparse tree coverage on a rocky site.

cont'd page 72.

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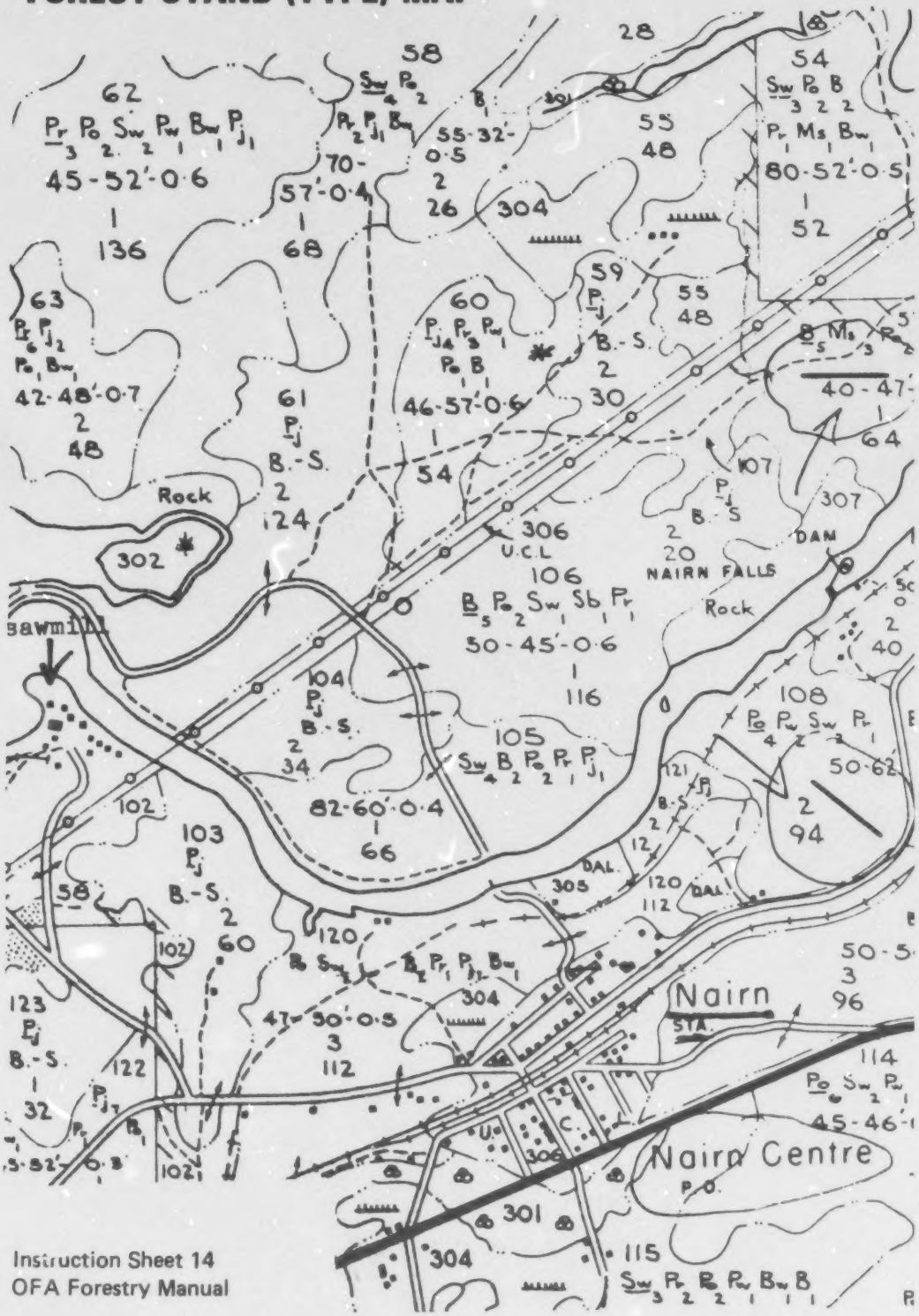
FOREST STAND (TYPE) MAP



Instruction Sheet 14
OFA Forestry Manual

— shown as follows above the species composition when the conditions apply

P.F.
$\underline{Po_0}$ Bw_3 Pw_1

$$\underline{\text{Stocking}} = \frac{\text{actual basal area}}{\text{normal basal area}}$$

eg. 0.5 has half the basal area of a "normal" stand. Normal refers to an optimum for that particular site.

Site class is based on a graph of height over age. (3 lines for the 3 site classes or one line for each of 1 – good 2 – medium 3 – poor.

Comments on Type Map Accuracy

i) Up to date? The Forest Stand (Type) Map (Instruction Sheet No. 14 on page 71) is based upon a 1960 cruise. Since then there has been a lot of growth balanced somewhat by fire, insects, diseases, cutting windthrow, etc.

ii) Photo interpretation varies in terms of accuracy depending upon the skill of the interpreter, quality of the photo, etc. Stands on the photo have to be compared with known types to arrive at a description. Ground checking is necessary to some degree.

iv) Despite probelms aerial photography makes it possible to assess large areas of forest with a minimum expenditure of time and money.

ACTIVITY

Students may be able to visit a forest area and compare type maps and photographs with existing ground conditions.

3.2 MAP SCALES

The map **scale** refers to the distance on the map in relation to the distance on the ground. A **large scale map** permits greater detail of a smaller area while a **small scale map** limits the detail that can be shown. For example:

10 cm on the map = 1000 metres (I km) on ground
is large scale **compared** to
10 cm on map = 50,000 metres (50 km) on the ground.

a) Types Of Map Scales Description

i) Statement type eg. 10 cm to 2 kilometres

ii) Bar or linear A bar relating map and ground distances. See map on page 74. Instruction Sheet No. 15)

iii) Representative Fraction (R.F.) One unit on the map represents so many of the same units on the ground.

eg. 1 cm on map = 15,840 cm. on ground

A common R. F. scale now in use is 1: 20,000 with 10 metre contours.

b) Measuring Distances On A Map

Straight lines – a straight edge or ruler can be used.

Curved or irregular lines – a swing measuring device is needed – a ruler, paper edge, string, etc.

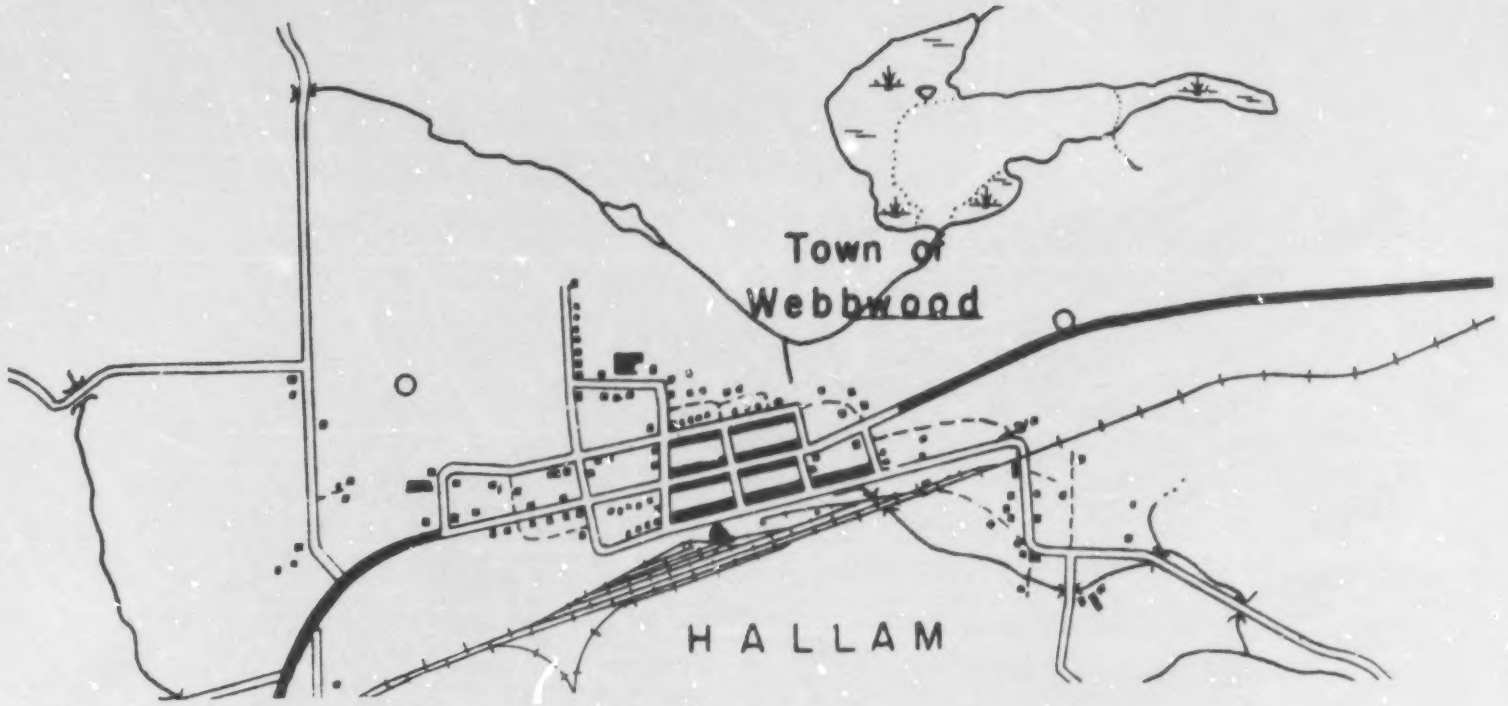
(Film strip – Introducing Map Scale)

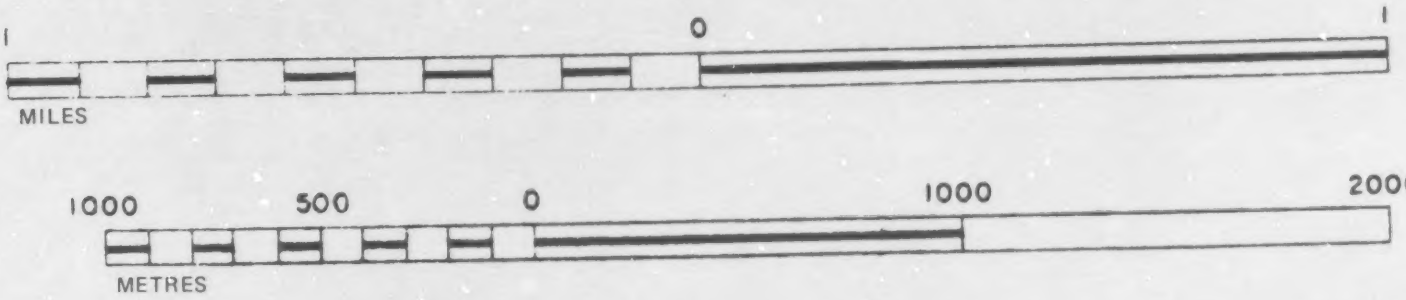
ACTIVITY

The Webbwood sheet that follows on page 74 can be used to measure distances between various points and scales. (The miles scale is based on four inches to the mile – a fairly common scale on older maps.)

How many hectares does the town occupy?

What portion is taken up with roads?





SCALE - 1:15,840

BASE MAP

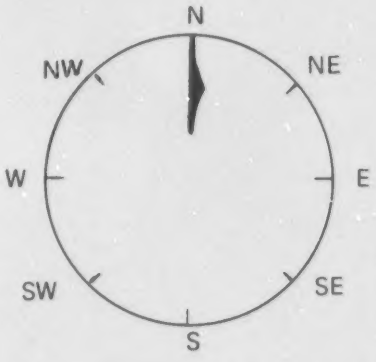
3.3 COMPASSES

The importance of compasses are many. Practice sessions in the classroom and outside are desirable if their use is to be appreciated and their values understood.

There are many types of compasses of which three are described below.

a) Simple Compass

A **simple compass** has the directions or points marked. The user turns the compass so that the north end of the needle points to North on the compass dial. Keeping the compass in that position read whatever bearing is required.

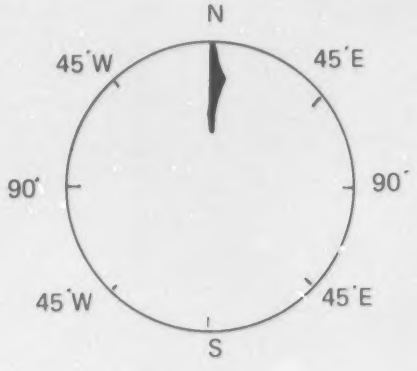


b) Sighting Compasses

"Sighting" compasses require setting or reading of the desired bearing by moving the dial to the point marked by a dot at the front of the compass. The north end of the needle is made to coincide with the arrow marked on the compass by turning the compass. A "sight" can then be lined up in the desired direction.

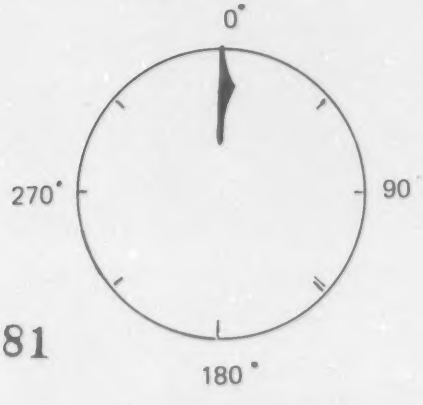
i) A Four-Quadrat Sighting Compass

These show four quadrats of 90° each east and west of north and south.



ii) A Forestry Sighting Compass

These show a 360° circle running clockwise.



For general direction – hold the compass waist high with the lid fully open and, standing squarely behind the compass, sight straight ahead noting some tree, rock or other stable feature that is in line with the bearing. Walk ahead and repeat as necessary.

For more accurate direction – hold the compass at eye level with the lid leaning towards you at such an angle that you can clearly read the compass needle position. Turn until the needle and the printed arrow coincide then raise your eye to sight along the upper edge of the lid. This will give you the desired direction.

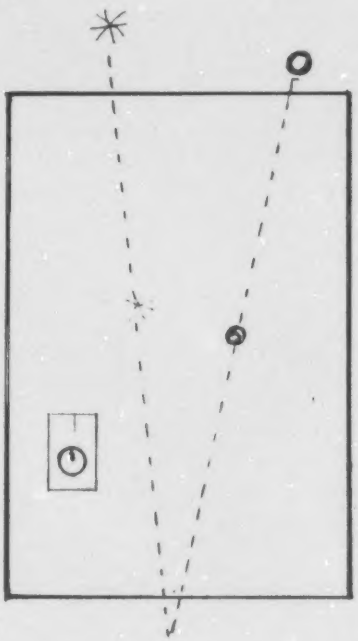
3.4 MAP ORIENTATION

Practical exercises in and out of the classroom are important. Film strips are available such as "Map Orientation" from the Canadian Forces.

When you "orient" a map you line it up with ground details. This is done by either using a visible features on the ground or with a compass.

a) **Orientation With Visible Features**

Set the map so that hills, roads, lakes, etc. on the ground are in line with the same details on the map.



b) **Orientation With A Compass**

Swing the map into position so that the north-south line parallels north-south on the compass. For accuracy this setting should include an adjustment for declination (see page 77).

c) **To Obtain A Bearing From A Map (Using a forestry compass)**

A person may wish to know what bearing to follow with a compass in travelling from one known point to another. This is done as follows:

- orient the map to true north using a compass.
- lay the compass on the map so that one of its sides is parallel with the desired direction.

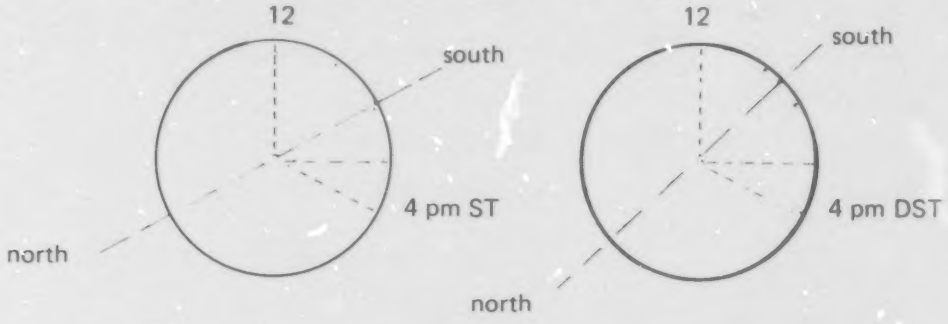
- while holding the compass in this position on the map turn the dial to a point where the orienting arrow below is in line with the north end of the compass needle.
- the degree reading is the desired bearing.

d) Getting A Bearing From The Sun and A Watch

Obviously this will not work on cloudy days or with digital watches.

Point the hour hand (standard time) at the sun. Half way between the hour hand and twelve o'clock is south. At noon, standard time, the sun is due south.

For daylight saving (fast) time an hour allowance must be made.



3.5 DECLINATION

Declination is the angle between true north and magnetic north. It may vary a small amount from year to year. Some maps show the declination that applies in a particular year.

In Thunder Bay the true north pole and the magnetic north pole are in alignment and this is the **zero declination** line. In Espanola the **westerly declination** is 7°. This means that the compass needle points **west** of true north to that extent.

In going from a **compass bearing** to a **map bearing** in this situation **subtract** 7° to get the map bearing.

In going from the map bearing to a compass bearing you must **add** 7°.

Unless a person is sure of the process it is best to make a little sketch when figuring out the declination. Remember, magnetic north is south of the true north pole.

Compass Adjustment

When using a compass in a particular area it is not necessary to keep setting the declination with every reading as the compass can be adjusted to allow for it and so the setting needs only be made once.

Local Magnetic Attraction

Occasionally mineral deposits or a metal object (eg. an axe) will attract a compass needle making its position incorrect. If a compass needle is acting strangely some local attraction is probably the problem. A person's immediate reaction is "This compass has gone crazy". Despite this possibility the general rule is to **believe your compass** in most situations.

3.6 AREA MEASUREMENT ON MAPS

a) Units

Though metric units are becoming the normal practice there are still occasions when a knowledge of imperial units is necessary for conversion purposes.

i) **Metric units of area**

The **hectare** (ha) is standard.

1 ha = 100 m x 100 m = 10,000 m^2

ii) **Imperial units of area**

The **acre** = 43,560 sq. ft.

(208.71 x 208.71 = 43,560)

640 acres = 1 sq. mile

iii) **Comparison of metric and imperial**

1 ha = 2.47 acres (2½ approx.)

1 acre = 0.40 ha.

Determining Areas On A Map

There are several methods of which two follow:

i) **Dot sheet method**

A transparent sheet with evenly spaced dots representing so many hectares per dot is placed over the map area to be measured. The dots within the area are counted and marked off with a grease pencil to avoid confusion. The number of hectares represented by one dot will vary with the map scale and the dot grid.

ii) **Planimeter**

Planimeters come in various styles. One is a low, 3-legged device that rests on a map and has movable sections and an arm with a small pointer on it. The pointer is used to follow the boundary of the area to be measured and the area is read directly from a meter that is part of the planimeter.

ACTIVITY

If a dot sheet is available students can practice this procedure. It adds to the interest if a forest type map is used since the areas shown on these give the area for each type description. In this way the student can find out how closely he or she agrees with the map maker.

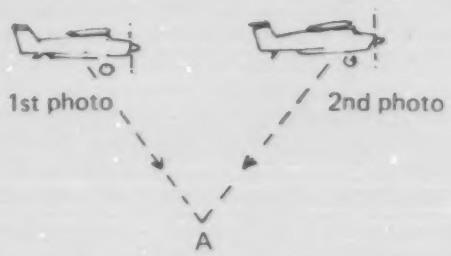
3.7 AERIAL PHOTOGRAPHY

Much of the aerial photography in use in Ontario has been taken from planes flying at **8,000 feet**. This gives an approximate scale of 4" to 1 mile, making it approximately the same as the base map scale. The flight lines and the camera setting are set so that the photographs overlap, a necessary condition for stereoscopic viewing.

Using a **pocket stereoscope** and overlapping photographs it is possible to get 3-dimensional detail giving "depth" to what is seen on the aerial pictures.

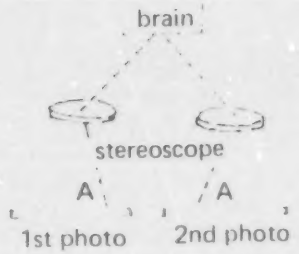
a) **Basis of Stereoscopic Effect**

As the plane flies along it takes two pictures of point 'A' from different angles.



Using a stereoscope on overlapping photos, one eye sees the point from one angle, the other eye sees the **same point** from a different angle.

These two images overlap in the brain, giving the 3-dimensional (depth) effect.



b) **Photo Identification** (Numbering)

See bottom right-hand corner of photograph.

eg. 73 4609
20 71

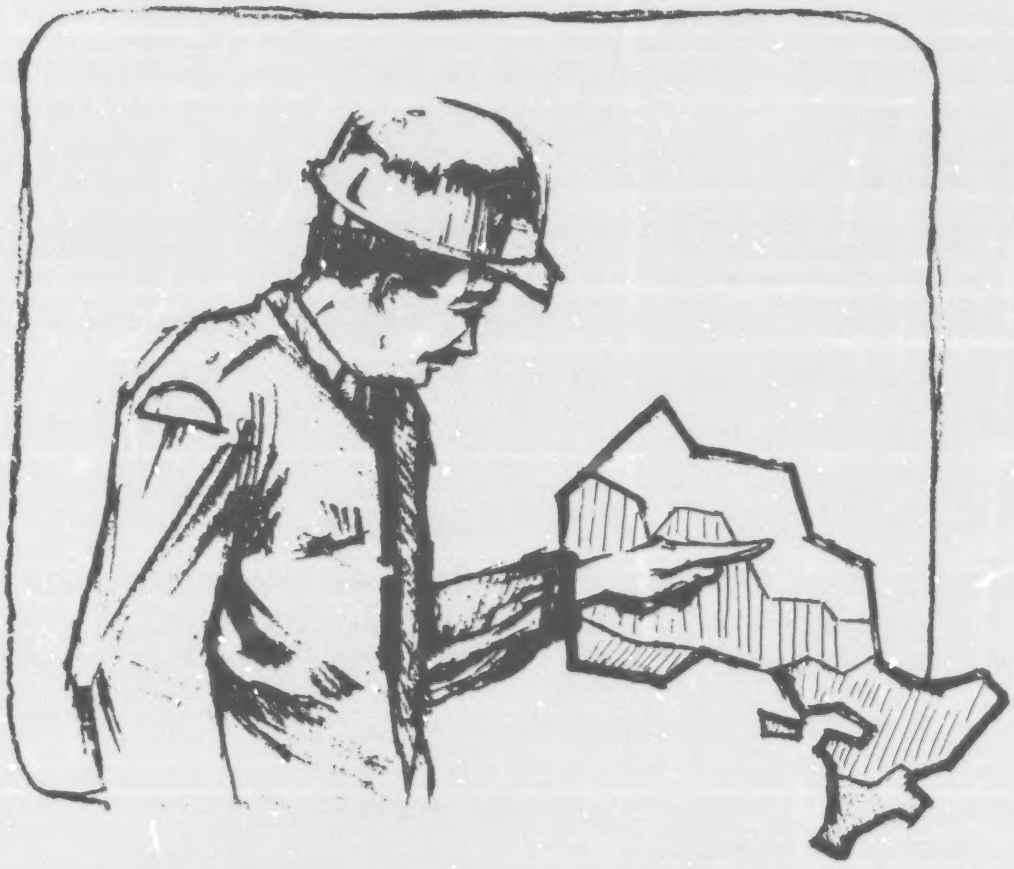
73 – year picture taken
4609 – strip number flown by plane and recorded on a map.
20 – film roll number
71 – picture number on roll

ACTIVITY

Practice getting the stereoscopic effect with paired aerial photographs.

It may be possible to compare photographic details with corresponding parts of forest type maps.

UNIT 4
CANADIAN FOREST GEOGRAPHY



UNIT 4: CANADIAN FOREST GEOGRAPHY

OBJECTIVE

Students should be familiar with where major tree species grow in Canada and the importance of the forests to our social, economic and environmental well-being.

4.1 FOREST REGIONS

Canada can be divided into ten distinct regions on the basis of marked differences in terrain, soil and climate. Eight of these are forest regions, one is grassland and one is tundra.

The eight forest regions and their principal tree species are:

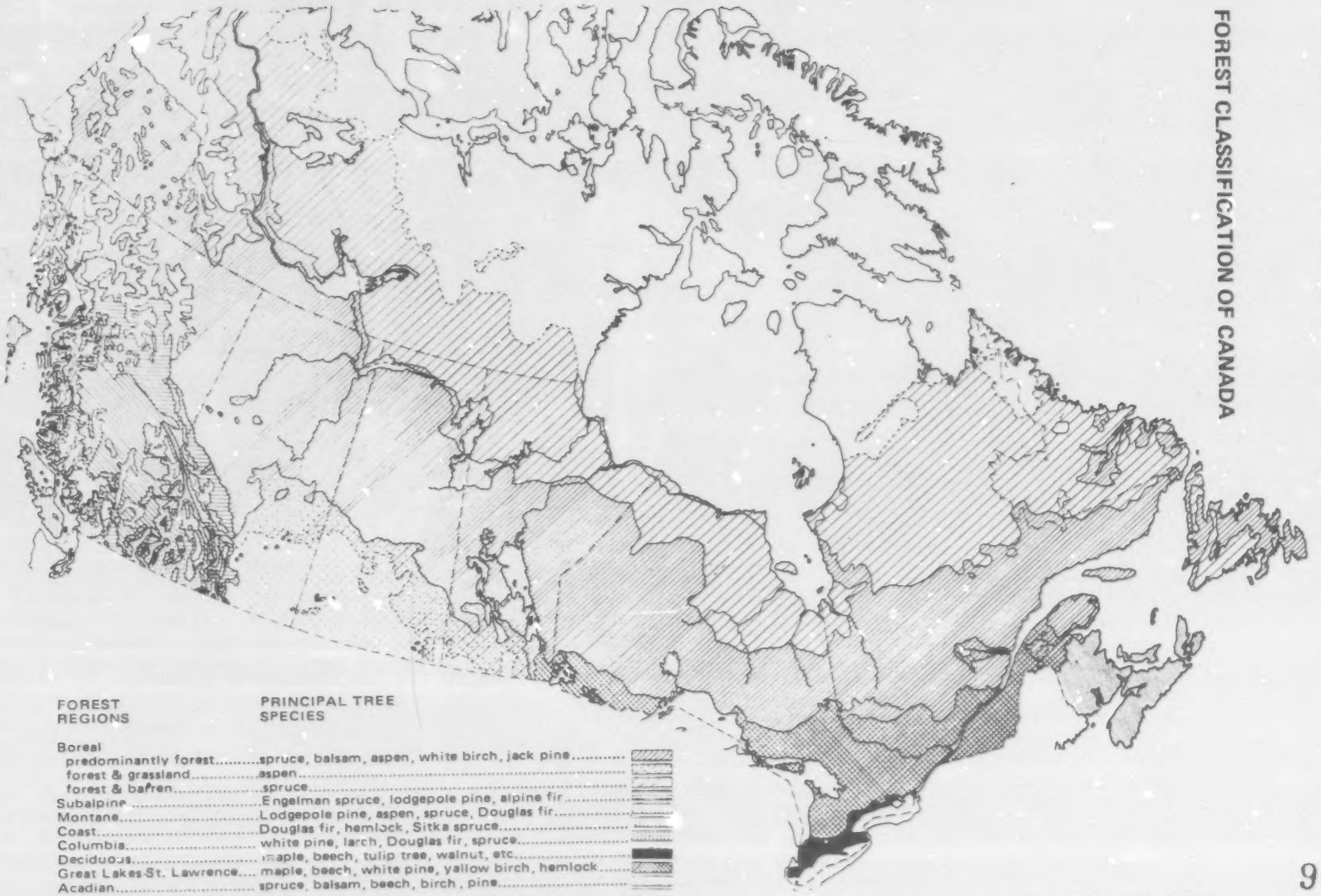
Boreal	Spruce, balsam, aspen, white birch, jack pine
Great Lakes-St. Lawrence	Maple, beech, white pine, yellow birch, hemlock.
Deciduous	Maple, beech, walnut, tulip, hickory
Acadian	Spruce, balsam, birch, maple, beech, pine
Coast	Douglas fir, hemlock, Sitka spruce
Columbia	Pine, larch, Douglas fir, spruce
Montane	Lodgepole pine, aspen, spruce, Douglas fir
Subalpine	Engleman spruce, lodgepole pine and alpine fir.

The history of settlement in Canada has been tied closely with rivers, forests and arable lands. No doubt much of this will be covered in other courses. Our particular concern is with the places trees grow, the kinds that grow there, their association with others and the natural conditions with which we must deal in managing our forests.

ACTIVITIES

A map of Canada's forest regions is provided on page 84. There is also a map of Canada (page 95) which could be duplicated and issued to students to mark in the Canadian forest regions. Instruction Sheet 17, on page 85, lists the forest regions and provides spaces for students to fill in information relative to forest regions and their map sheet.

FOREST CLASSIFICATION OF CANADA



FOREST REGIONS	PRINCIPAL TREE SPECIES
Boreal	
predominantly forest	spruce, balsam, aspen, white birch, jack pine
forest & grassland	aspen
forest & barren	spruce
Subalpine	Engelman spruce, lodgepole pine, alpine fir
Montane	Lodgepole pine, aspen, spruce, Douglas fir
Coast	Douglas fir, hemlock, Sitka spruce
Columbia	white pine, larch, Douglas fir, spruce
Deciduous	maple, beech, tulip tree, walnut, etc.
Great Lakes-St. Lawrence	maple, beech, white pine, yellow birch, hemlock
Acadian	spruce, balsam, beech, birch, pine
Grassland	
Tundra	

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CANADA'S FOREST REGIONS

Name _____

Class _____ Date _____

Instructions

Using Native Trees of Canada as your reference
(Inside covers and pages 16-23)

1) Draw in the approximate boundaries of the forest regions on the map provided.
2) Code the regions using colours and/or numbers.
3) Complete the form below.

(Some class time will be allowed. All are to hand the project in.)

Region (See legend)	Map Coding (Colours/no's)	Main species (abbreviate)	Other important features
Boreal a) Forest			
b) Forest/grass			
c) Forest/barren			
Subalpine			
Montane			
Coast			
Columbia			
Deciduous			
Great Lakes-St.L.			
Acadian			

Instruction Sheet 18
OFA Forestry Manual

4.2 FOREST STATISTICS AND IMPORTANCE

Students should be given an opportunity to understand and appreciate the economic importance of forests to Ontario and Canada. The problem is to make the data interesting and impressive rather than dry and boring.

Examples of statistical data follow. Copies of this type of information can usually be obtained from various government, industry and association sources. Familiarity with these could be of continuing benefit to the students for future reference. The data which follows is from two publications:

- Canada's Forests 1982 from the Canadian Forestry Service
- Ontario's Forests at a Glance (1983) from the Ontario Forestry Association

World Forestry Data

	Forest area '000 km^2	Growing stock '000 000 m^3
North America		
Canada	4 370	19 600
United States	2 980	20 100
Mexico	30	600
Central America	570	4 900
South America	5 300	91 500
Africa	1 900	25 000
Europe	1 400	12 000
USSR	7 900	84 200
Asia	4 000	38 000
Oceania	800	6 000
Total	**29 250**	**301 900**

Sources: Canadian Forestry Service: World Forest Resources, Reidar Persson, Royal College of Forestry, Department of Survey, Number 17, 1974. Stockholm, Sweden, and FAO/ECE Country Profiles.

	Roundwood Production Average 1976-80	
	Industrial	Fuelwood
	'000 000 m^3	
North America		
Canada	147	4
United States	328	14
Mexico	6	5
Central America	5	29
South America	60	237
Africa	47	363
Europe	273	43
USSR	288	80
Asia	204	786
Oceania	25	7
Total	**1 383**	**1 568**

Source: Statistics Canada and FAO Yearbook of Forest Products Statistics, 1980.

Wood Volume*

By Province and Territory	Softwoods	Hardwoods	Total
	'000 000 m^3		
Newfoundland	429	34	463
P.E.I.	22	11	33
Nova Scotia	137	65	202
New Brunswick	338	178	516
Quebec	3 089	1 044	4 133
Ontario	2 075	1 123	3 198
Manitoba	438	196	634
Saskatchewan	293	191	484
Alberta	781	657	1 438
British Columbia	7 438	404	7 842
Yukon Territory	215	40	255
N.W.T.	315	131	446
Total	**15 570**	**4 074**	**19 644**

Species Groups	'000 000 m^3		'000 000 m^3
Softwoods		Hardwoods	
Spruce	6 116	Poplar-aspen	2 248
Pine	3 041	Birch	957
Fir	2 715	Maple	499
Hemlock	1 224	Unspecified	370
Cedar	784		
Douglas fir	614		
Unspecified	1 076		
Total	**15 570**	**Total**	**4 074**

*Gross merchantable volume on stocked, productive, non-reserved forest land.
Source: Forestry Statistics and Systems Branch, Canadian Forestry Service.

Primary Forest Production

By Product	1981 '000 m^3	1976-80 Average '000 m^3
Logs and bolts		
Softwoods	91 904	102 385
Hardwoods	4 414	4 969
Pulpwood		
Softwoods	37 167	34 580
Hardwoods	4 037	4 019
Fuelwood		
Softwoods	1 410	1 167
Hardwoods	4 078	3 010
Other roundwood products	1 562	1 511
Total primary products	**144 572**	**151 641**

By Province and Territory	1981 '000 m^3	1976-80 Average '000 m^3
Newfoundland	2 568	2 421
P.E.I.	333	193
Nova Scotia	3 986	4 044
New Brunswick	7 795	8 165
Quebec	34 234	32 325
Ontario	22 808	19 763
Manitoba	1 803	1 913
Saskatchewan	3 555	3 119
Alberta	6 586	6 446
British Columbia		
Coast	22 501	30 871
Interior	38 279	42 230
Yukon & NWT	124	151
Total Canada	**144 572**	**151 641**

Forest Industries

Employment	Number of Employees	Salaries and Wages $000 000
	1980	1980
Logging	**55 897**	**1 179**
Wood Industries		
Sawmills & planing mills	66 811	1 379
Shingle mills	2 075	44
Veneer & plywood mills	12 363	243
Sash, door, & other millwork	25 170	372
Other wood industries	11 898	179
Total wood industries	**118 317**	**2 217**
Paper & allied industries		
Pulp & paper mills	86 872	2 050
Other paper industries	43 455	734
Total paper & allied industries	**130 327**	**2 784**
Total forest industries	**304 541**	**6 180**

Value of Products	Value Added $000 000	Value of Shipments $000 000
	1980	1980
Logging	**2 049**	**4 559**
Wood industries		
Sawmills & planing mills	2 089	5 278
Shingle mills	66	152
Veneer & plywood mills	346	840
Sash, door, and other millwork	668	1 425
Other wood industries	298	702
Total wood industries	**3 466**	**8 397**
Paper & allied industries		
Pulp & paper mills	5 355	10 908
Other paper industries	1 415	3 595
Total paper & allied industries	**6 770**	**14 503**
Total forest industries	**12 285**	

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AREA OF ONTARIO ('000 ha)

Total Area	106,900	Land Area	84%
		Water Area	16%

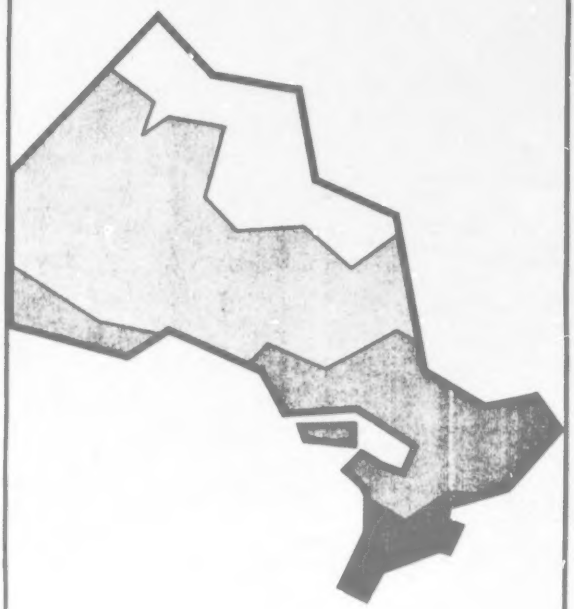
Source: Canadian Forestry Service (CFS) 1982

LAND CLASSES ('000 ha)

Productive Forest Land*	56,600
Agricultural Land	6,700
Urban and Cleared, Developed Land	700
Wildland	24,500
Total	**88,500**

*Productive Forest Land (PFL) has the ability to support tree growth to commercial size and volume.

Source: CFS 1982



FOREST REGIONS ('000 ha)	Total Land Area	Productive Forest Land
Boreal Barrens	24,556	8,816
Boreal Forest	42,335	35,364
Great Lakes-St. Lawrence	19,492	12,265
Deciduous	2,092	165
Total	**88,500**	**56,600**

Source: CFS 1981

MAIN SPECIES COMPOSITION

Boreal Barrens – black spruce, white spruce, tamarack, poplar
Boreal Forest – black spruce, white spruce, jack pine, white birch, balsam fir, poplar
Great Lakes-St. Lawrence – white pine, spruce, red pine, sugar maple, white birch, red oak, yellow birch
Deciduous – sugar maple, beech, basswood, oak, walnut

PRODUCTIVE FOREST LAND OWNERSHIP ('000 ha)

	Private	Provincial	Federal	**Total**
Area	4,900	51,100	600	**56,600**

Source: CFS 1982

GROWTH OF THE FOREST RESOURCE

	Mean Annual Growth (m^3/ha)	Total Annual Growth ('000 m^3)	% of Total Annual Growth In Ontario
Ontario			
Boreal Barrens	0.6	4,933	6
Boreal Forest	1.6	57,783	68
G. L. – St.-L.	1.8	22,019	26
Deciduous	2.5	415	>1
Total	**1.5**	**85,150**	**100**

Source: CFS 1981

GROWING STOCK DISTRIBUTION ('000 m^3)

	Crown	Private	Total
Conifer			
Northern Ontario	1,906,644	116,595	2,023,239
Southern Ontario	17,143	37,074	512,217
Total	1,923,787	153,670	2,076,823
Hardwood			
Northern Ontario	1,228,579	155,254	1,383,833
Southern Ontario	43,234	133,578	176,812
Total	1,271,813	288,832	1,560,645
Total	**3,195,600**	**442,500**	**3,638,100**
Mean Growing Stock m^3/ha	**109.2**	**105.6**	

Growing Stock is the total volume of wood.
Source: Ontario Ministry of Natural Resources (OMNR)

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SEEDLINGS DISTRIBUTED 1982/83 ('000 seedlings)

	Bare Root	Container		Total
	Public	Public	Private	
Crown Land And Agreement Forests	41,644	10,990	5,466	58,100
Woodlands Improvement Act	9,182		–	9,182
Other Private Lands	12,033		–	12,033
Education or Science	801		–	801
Total Distribution	**63,660**	**10,990**	**5,466**	**80,126**

Source: OMNR 1983

OMNR SILVICULTURAL OPERATIONS (ha)

	79/80	80/81	81/82	82/83
Regeneration[2]	79,909	104,810	86,563	92,767
Retreatment	3,831	9,574	4,273	4,292[1]
Tending	39,229	51,036	41,445	54,506
Site Preparation	50,994	53,380	55,505	70,998
Marking	66,485	57,292	53,995	53,953
Total	**240,448**	**276,092**	**241,781**	**272,224**

[1]Retreatment not included in total for 1982/83
[2]Does not include areas that will regenerate naturally
Source: OMNR 1983

FOREST MANAGEMENT 1982/83

	No.	Area (ha)
Forest Management Agreements	13	721,800
Woodland Improvement Act Agreements	9,920	160,600
Agreement Forests (Forestry Act)	58	110,800
Company Forest Management Units	13	13,912,000
Crown Forest Management Units	77	33,307,100

Source: OMNR 1983

FOREST FIRES

	79/80	80/81	81/82	82/83
Number	1,564	1,779	1,656	1,396
Area burned (ha)	53,715	560,740	179,473	3,892

Source: OMNR 1983

ANNUAL TIMBER BALANCE
(Crown Lands only)

	Total Softwood	Total Hardwood	Total
Allowable Cut[1] (Millions m^3)	25.19	11.43	36.62
Actual Cut[2] (Millions m^3)	14.26	2.52	16.78
Actual/Allowable (%)	56.6	22.1	45.8

[1]Allowable cut figures are based on 1981/82 calculations
[2]Actual cut figures are an average of a 5 year period.
Source: OMNR

CLASSIFICATION OF CUTOVER AREA (ha)

	79/80	80/81	81/82	82/83
Crown	176,470	196,377	179,523	178,191
Patent	42,108	45,307	48,081	45,000
Total	**218,578**	**242,684**	**227,604**	**223,191**

Source: OMNR 1983

FOREST INDUSTRY PRODUCTION

	1980	1981	1982
Roundwood Receipts (m^3)	24,407,140	23,598,210	19,303,130
Lumber (m^3)	4,331,880	4,301,880	3,375,370
Plywood (m^3)	121,030	124,510	88,620
Veneer (m^3)	185,740	149,800	159,660
Particleboard (m^3)	318,270	320,810	235,350
Waferboard (m^3)	316,410	339,590	258,640
Pulp (tonnes)	3,972,168	3,950,996	3,270,667
Paper (bone dry tonnes)	2,828,799	2,788,735	2,464,085
Residues (tonnes)			
Pulpchips	2,114,722	1,960,670	1,568,626
Shavings	289,913	336,716	292,965
Sawdust	580,047	602,029	476,091
Bark	1,203,241	1,183,127	827,912
Other Forest Products			
Maple Syrup (L)	468,000	659,000	768,000[1]
Maple Sugar (kg)	3,630	5,900	21,320[1]
Christmas Trees (No. sold)	–	853,307	602,307[2]

Source: OMNR 1983
[1]Source: Statistics Canada (SC)
[2]Source: CTCAO 1983

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FOREST INDUSTRY PRINCIPAL STATISTICS 1981

	Establishments (No.)	Employment (No.)	Salaries and Wages ('000 $)
Logging	418	9,003	230,052
Wood Industries	774	20,970	362,998
Paper and Allied Ind	342	47,381	1,044,810
Total	**1,534**	**77,354**	**1,637,860**

Source: SC

FOREST INDUSTRY REVENUES AND EXPENDITURES 1981 (Millions $)

Value of Shipments	7,283.8
Expenditures	
Salaries & Wages	1,637.9
Costs of Materials and Supplies	3,876.2
Cost of Fuel and Electricity	399.4
Capital and Repair Expenditures	582.4

Source: SC

GOVERNMENT OF ONTARIO DIRECT REVENUES AND EXPENDITURES (Million $)

	79/80	80/81	81/82
Expenditures			
Forest Management	65.9	84.0	109.6
Forest Protection	29.1	61.9	46.8
Forest Access	11.2	16.6	19.9
Total Expenditures	**106.2**	**162.4**	**176.3**
Revenues			
Stumpage	46.2	43.7	42.5
Area Charge	5.4	4.0	4.4
Other Timber Revenue	1.1	2.0	3.7
Federal Reimbursements	1.4	6.1	10.9
Total Revenues & Reimbursements	**54.0**	**55.8**	**59.5**

Source: OMNR 1982

ONTARIO TRADE BALANCE FOR FOREST PRODUCTS (Millions $)

	1980	1981	1982
Exports	2,173.5	2,449.3	2,316.5
Imports	433.0	515.7	451.4
Surplus (Deficit)	1,740.5	1,933.6	1,865.1

Source: SC 1983

LOCAL FORESTRY STATISTICS
(Fill in Current Data)

ACTIVITIES

Working with the type of data provided can be made more interesting, and provide experience in interpreting statistics, if it is the basis of a project. These could be of a variety of types and deal with local, provincial, national and international matters. The following are examples of the types of questions that could be asked:

a) World Forestry Data

i) In terms of productive forest area list the world's top three nations.
ii) Based on roundwood production list the world's top three countries.
iii) What percent of roundwood production is fuelwood? In Canada? In the USSR?

b) Area Classification

i) Of Canada's total land area what percent is forest?
ii) What is "reserved" forest land?
iii) Based on total non-reserved forest land list Canada's top three provinces.

c) Suitability of Tenure

i) What percent of Canada's forest land is privately owned?

d) Merchantable timber

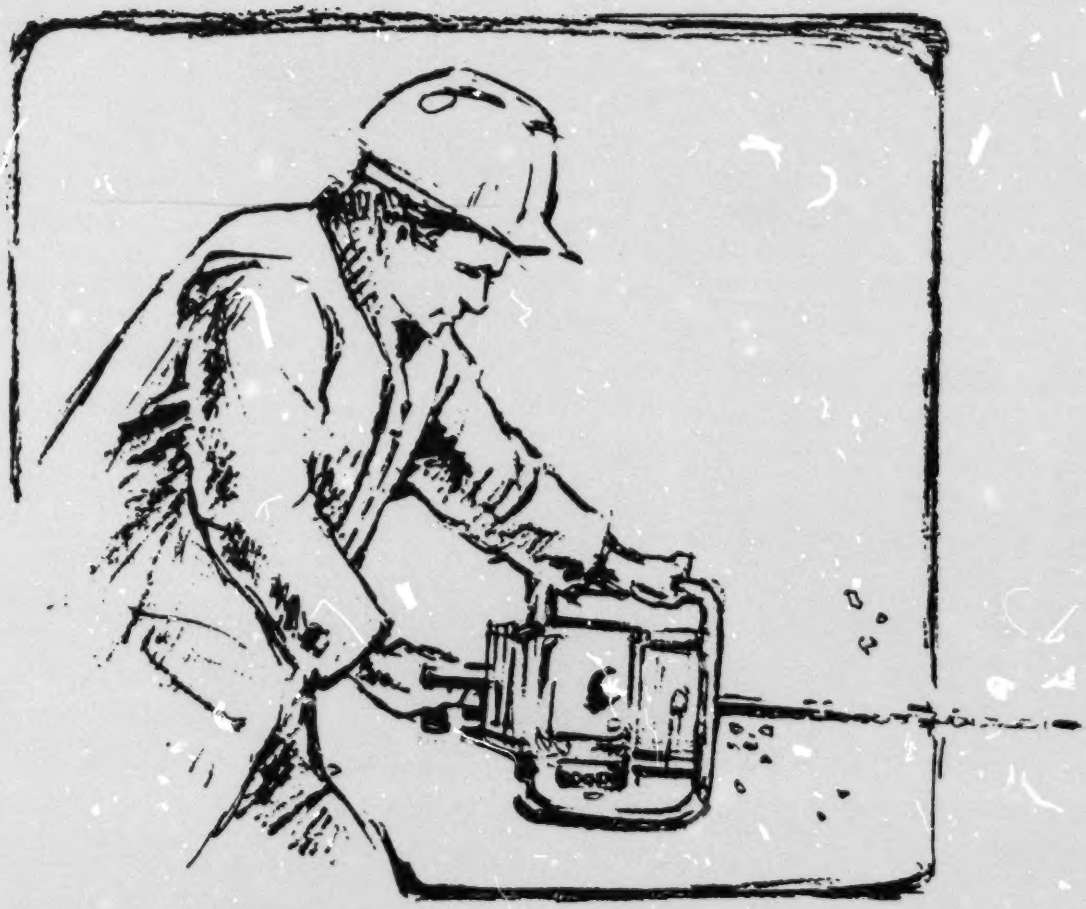
i) What percent of merchantable timber in Ontario is conifer?

e) Recreation

i) On what percent of Ontario's forest land is outdoor recreation banned?

Many activities are possible and could be of the student's own choosing with reports to be given orally or handed in.

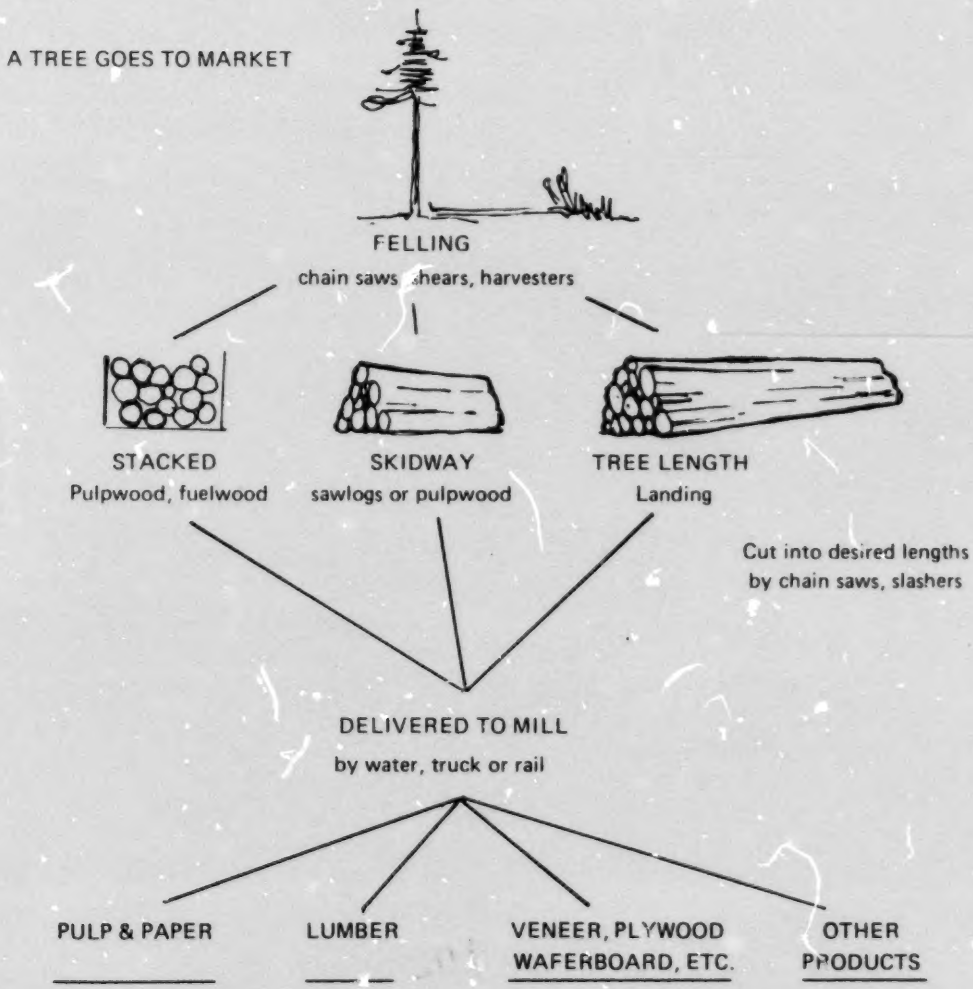
UNIT 5
LOGGING & UTILIZATION



UNIT 5: LOGGING & UTILIZATION

OBJECTIVE

In previous units consideration was given to where and what kinds of forests we have, their ownership and importance. This unit deals with moving wood from the stump to the finished product. Trees must be found, cut and moved to mills or fuel yards for processing if lumber, paper and other products are to be made. The diagram below illustrates some of these steps.



5.1 FELLING

a) Equipment

Trees are cut down in a variety of ways. In the past this was done with large cross cut saws and small **Swede saws** which have a light metal frame holding a saw blade.

Today, felling is done using **chain saws** (power saws) and various types of **harvesters.** Harvesters are machines that move through the bush and do a variety of things with trees depending on their design and purpose. Some have rubber-tired wheels; others move by tracks. Some cut the tree down using a chain saw; others do this by means of an hydraulically-controlled, knife-like shear. A number of them have a device that runs up the tree trunk trimming off the branches before the tree is felled.

The names given various types of harvesting machines indicate their functions:

Feller bunchers
Feller forwarders
Feller limber bunchers

b) Safety

Felling trees is dangerous unless the work is done with safety in mind. Common accidents that occur are:

i) Dropping a tree on someone nearby. (In the past the cutter shouted "TIMBER" to warn that a tree was coming down. Today, however, equipment makes so much noise that this practice isn't much help.)

ii) The tree butt may "kick back" off the stump and hit the cutter.

iii) The saw blade may "kick back" out of the cut and hit the cutter. (This is usually caused by the blade hitting some brush.)

iv) Falling pieces from tree tops or "chicos" (dry stubs) hit by the falling tree may cause accidents.

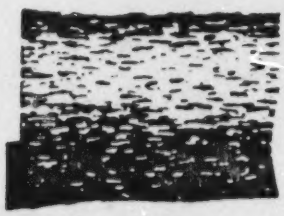
v) The tree being cut may "hang up" on another tree. Releasing it can be dangerous.

vi) Wind or tree lean can cause the tree to move in an unexpected manner. Be prepared.

c) Felling Direction

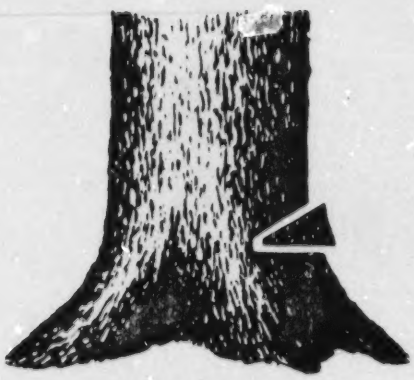
i) The undercut or notch

Humbolt undercut

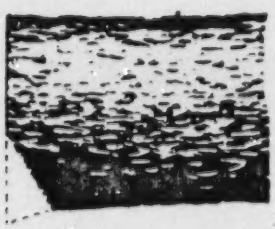


No volume loss
due to undercut

Canadian Forestry Service.



Conventional undercut



Potential volume loss
due to undercut

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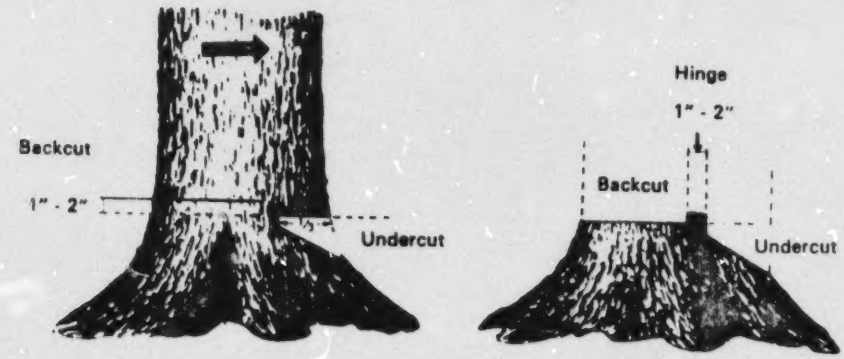
ii) The felling cut or backcut

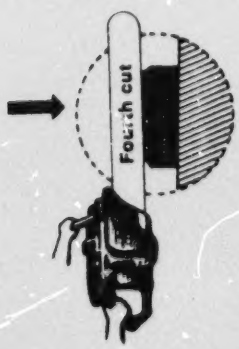


iii) Felling leaning trees

Step 1: Humbolt undercut

Step 2: Cut at 45° angle to undercut and rotate saw to cut 90° to undercut for several inches

Step 3: Same as for Step 2



Step 4: Make backcut in conventional manner

Canadian Forestry Service

Some splinter pull may develop but it is confined to lower quality heart zone

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5.2 SKIDDING AND YARDING

Skidding refers to pulling wood from the stump after felling to another point at which it may be piled, cut into lengths or loaded for transport elsewhere. It may be done in various ways:

a) By Horses

This used to be a common method but is now rare. The horse would drag the log from the stump to the skidway, frequently on its own with the cutter hitching on the log and the person at the skidway unhitching it. With rising fuel costs the horse may make a come-back.

b) By Mechanical Skidders

There are two kinds – tracked and wheeled skidders. The former is better in wet swampy areas. Wheel skidders are more common and move faster.

Skidders are equipped with a winch and cable. The cable is run out to the wood where "choker slings" are wrapped around the logs. The logs are then winched up to the machine which usually lifts one end of the logs off the ground and the machine then "skids" them to the skidway where they are piled.

c) By Yarding

In this case a tall structure such as an A-frame (or a single spar tree or upright steel spar as found in British Columbia) is used in conjunction with a winch, cable and chokers. The winch pulls the wood in and it is either piled or loaded at this point.

A simple example of yarding equipment is the "jammer".

d) By Use of "Forwarders"

The feller forwarders may be used to cut the trees and load them on themselves to be taken to the skidway or landing when loaded.

5.3 BUCKING

Bucking is cutting wood into desired lengths. It may be done by:

a) cutters – after the trees are felled and limbed at the stump.

b) skidders – at the skidway by the skidder with a chain saw.

c) slashers – portable mills with circular saws, loaders, and conveyors for cutting tree lengths into desired lengths and piling the logs neatly.

d) harvesters – some types of feller harvesters are able to fell, top, limb, slash and pile logs on the unit and forward it when loaded.

5.4 PILING

Wood may be piled in a variety of ways by a variety of methods:

a) Stacked – manually or mechanically piled wood of short dimensions. Front end loaders, clams, and other devices may be used.

b) Skidways -- logs may be rolled into a pile by hand, by skidders or with the help of winches and cables or with front end loaders.

c) Tree length piles – piled up by skidders or bulldozers or by cables and winch.

5.5 WOOD DELIVERY

Wood is moved to the mill by three methods or a combination of them:

a) river drive
b) truck haul
c) rail

a) River Drives

River drives take advantage of the water available during the spring run off to move logs inexpensively and in large volumes with a minimum of handling. Water levels may be controlled by storage dams so that water is made available as needed. The dams may also be used for hydro power and flood control purposes. Initially the drive begins when one of the following takes place:

- Wood is dumped through the winter onto the ice where it stays until spring break-up and the drive is on
- wood is piled along the bank and pushed into the water
- wood is dumped into the water directly from trucks unloading from a ramp.

When the drive has to cross a lake, with little current to move the wood along, **log booms** are towed by **tugs** to do the job. This is called **rafting**.

River driving is becoming less common because:

i) Too much money is tied up while wood is in the water for long periods.

ii) Manpower has become too expensive. In the old days river drivers worked six days a week from dawn to dusk. Now union agreements call for 5-day weeks, time and a half for overtime, etc.

iii) Too much wood lost to sinkage.

iv) Drives tend to interfere with other river traffic.

v) River bottoms accumulate logs and bark.

vi) Truck and rail delivery have become competitive.

b) Truck Haul

With modern machinery for road construction logging roads can be built almost anywhere. Trucks can be used for short hauls to landings or railways or long distances from woods to mill.

Roads can be built to different standards depending upon the loads to be carried, the terrain, weather and seasons to be used.

There are many different kinds of trucks and trailers used in wood delivery such as:

5 ton trucks
dump trucks
tandems with dual axles
truck-trailer combinations
tractor-trailers with the circular "fifth wheel" hitch joining the tractor and trailer
chip trailers – made for hauling wood chips

Company Roads and Public Use

Loggers use both public and private roads. The latter are built and maintained by the companies using them. On these private roads government load restrictions, gas taxes and license plates do not apply to company vehicles restricted to these roads.

This situation results in problems at times as far as some members of the public are concerned. Although the roads are built and maintained by the industry some of the public feels that it should be able to use them if they are on **crown land** which is public property; as is the **wildlife** as well.

Companies pay an area fee (ground rent) which some of them feel provides exclusive use of their roads to themselves. Many companies permit public access without question at all or some times of the year while others, with larger numbers to deal with, are inclined to be more restrictive.

ACTIVITY –

To get students thinking upon this matter they might be given an assignment to list all the reasons they can think of that justify logging companies controlling traffic on their private roads. There should be at least four. They should not be too brief. They may wish to think of themselves as gatemen on a company road who were required to explain to would-be visitors the reasons for the company policies. They could discuss their views with the class or write them out and turn them in with their name, class and date noted.

Some possible answers:

- *Road building is expensive and increased traffic results in higher maintenance costs.*
- *Serious accidents are liable to happen involving company and private vehicles, with liability problems, etc.*
- *The fewer people that get into an area the less chance of forest fire. A major fire could wipe out a logging operation. (MNR applies travel restrictions during high hazard conditions.)*
- *Too many people leave a mess of litter behind.*
- *Damange to company property (vandalism) is often a problem.*
- *Theft is another problem.*
- *Hunters in logging areas can cause shooting accidents.*
- *Public vehicles interfere with the truck haul of wood.*

Some possible solutions:

- *Improved public education attitude and behaviour.*
- *Company control number of visitors allowed in at any one time (a permit system) and the times to avoid the log haul (eg. a week-end).*
- *After the logging is completed in an area, MNR may agree to maintain the road provided it is available for public use.*
- *A fee might be charged for the use of private roads.*
- *And others.*

c) **Rail**

Wood may be loaded at railway sidings. In the past railway **box cars** were loaded by hand. This was a slow laborious method but it kept the wood secure and none of the pieces could stick out to cause an accident.

Today rail wood is carried in two types of cars. Both are mechanically loaded, a process made possible by the fact they are open-topped. (Good for unloading, too.)

i) **Staked flat cars** – have the safety problem that sticks may stick out too far or the load may shift.

ii) **Gondola cars** – with steel sides resembling ore cars. (Called gondola cars as they are somewhat boat-like.)

5.6 WOOD STORAGE

Wood may be held at a mill:

- in water (eg. a **log pond** from which the logs move into the mill up a "jackladder" with its endless chain moving along a series of rollers.
- in a **log dump** in a mill **woodyard**.
- in **chip piles** on the ground or in bins.

There are risks in storing wood too long such as fire, insects, discoloration and decay.

5.7 DEVELOPMENTS AND TRENDS

There are many changes in the forest industries of which only six are mentioned here. You may wish to explore others with the class.

a) commuter camps
b) wood chips
c) improved utilization
d) changing market demands
e) new uses for wood
f) computers

a) **Commuter Camps**

Where possible, companies are switching from live-in camps to commuter camps where workers live at home and drive to and from work in the woods.

Camps with modern facilities are expensive to build and maintain, and the work force is happier living at home. In cases, a car allowance is provided, and car pools are often used. Buses and planes are also used.

b) **Wood Chips**

Sawmills in earlier times cut **slabs** from the outside of logs to square them up and remove the bark. Today the logs are barked and the wood not used for lumber on the outside of the log is chipped for use at the pulp mills. Approximately 30% of the wood used in mills today as chips would have been wasted under the old process. The integration of product lines regardless of ownership can help improve upon the effective utilization of the wood supply.

c) **Improved Utilization** – A Brief History

With improved utilization there is: **BETTER USE & LESS WASTE.**

Back in the early 1800s, when **square timber** was produced for the British navy, pine timbers 60 feet long had to be almost defect-free and a lot of wood that didn't measure up to this high standard was wasted.

This was followed by a period when **only the best pine and spruce** was cut for lumber. The demand was for clear lumber with very few knots.

Then **pulpwood logging** came into the picture using mainly spruce and balsam and jack pine more recently. As a result, smaller trees were being utilized.

Today the trend is to use all tree species **and** to leave as little wood in the bush as possible. Some pulp mills take all tree species, and operators are encouraged to send the larger logs to sawmills for lumber and veneer, with the smaller ones going to pulp mills. As mentioned earlier, converting slabs to **chips** has been a big improvement.

In the future we will probably see **whole tree logging** in which the complete tree, trunk, branches, and twigs, are converted into chips. And research is being conducted into **uses for bark.**

d) **Changing Market Demands**

From time to time **substitute products** compete with or replace wood and buyer demands may produce unexpected changes. For example:

i) In the past, clear **(knot-free)** lumber was considered to be much the best. Today, many people consider **knotty lumber** to be attractive; even wood with white fungus streaks is in demand.

ii) **Wall panelling**, featuring wood grains, is now produced by bonding a wood grain picture onto a wood panel. This is usually cheaper than the real thing, and it may be better looking as the picture shows a choice example of wood-grain pattern. The drawbacks include the fact that the picture is repeated on a wall and the thin surface scratches easily.

iii) **Plastics and metals** actively compete with wood in many instances.

e) **New Uses For Wood**

Research is being carried out to see if the chemicals in wood can be used efficiently as **fuel** for cars, etc.

Studies are being done on converting wood into **food products** for human consumption.

f) **Computers**

As in other fields, computers are revolutionizing the way forestry data can be handled. Cruise data, scaling information, cost summaries, statistics, and forecasts are all being processed using computers. Satellite-computers are showing a tremendous potential in assessing ground and forest conditions.

5.8 SAWMILLS

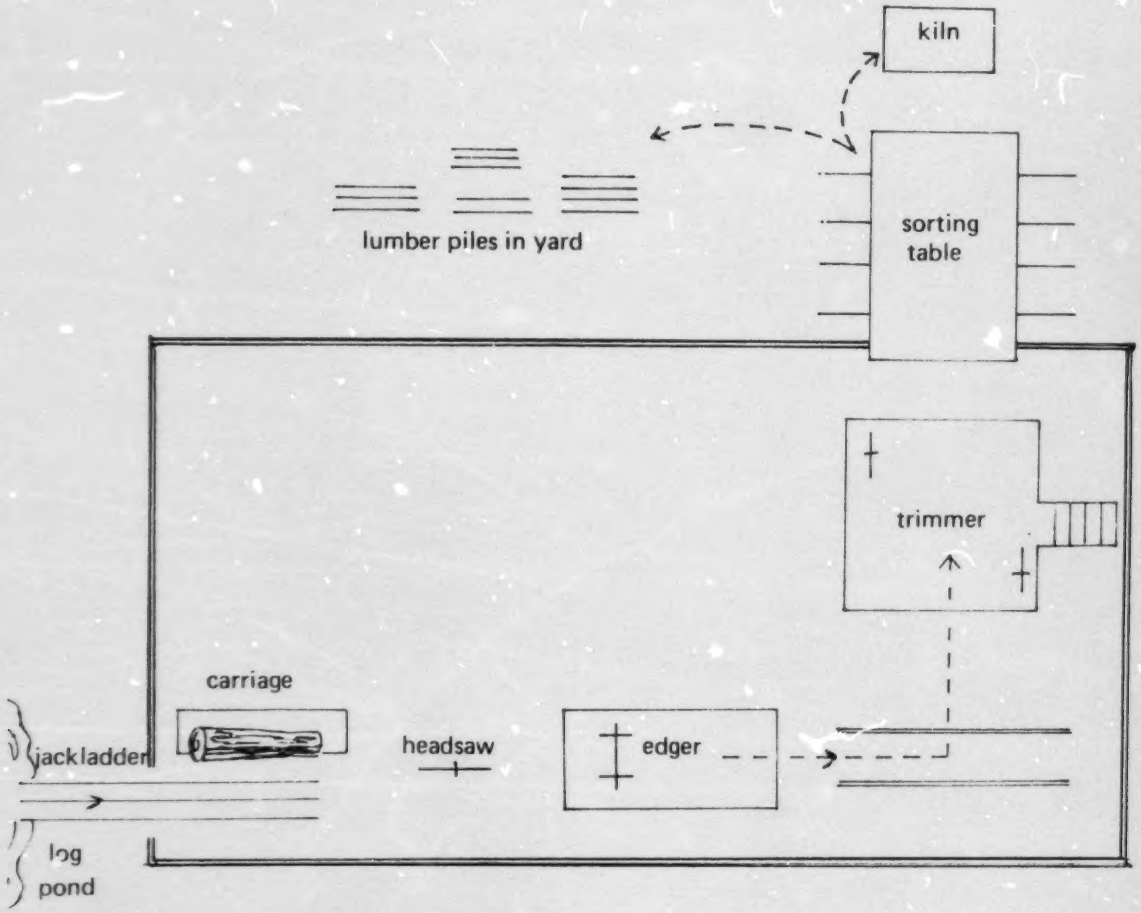
Sawmills vary greatly in size and complexity. The most modern are high-speed, computer-controlled operations. We will limit our sawmill coverage to a brief look at a small, basic mill layout (see p. 106) which will give students a basic idea of the processes and machines involved. (A visit to a sawmill makes a good field trip.)

The **sawyer** is a very important person in a sawmill. The quantity and quality of lumber produced depends a lot on the sawyer's judgement and skill. The way the log is turned on the carriage and pushed into the saw determines the amount of wood of highest value sawn by the mill. (See p. 107).

The **millwright** is responsible for the mechanical maintenance of the mill.

Saw kerf is the width of wood lost as sawdust when a log is sawn into boards. Circular saws with their large teeth tend to create more sawdust than do the thinner band saws and gang saws.

LAYOUT OF A SMALL SAWMILL



FIELD TRIP

A field trip is planned to the Nairn Sawmill, Nairn Plantation and the Menzies Mill.

1. **Instructions**

   a) Go to the **bus** after the home room period. It will be parked by the library entrance. Bus leaves shortly after 9.00 and returns at 3.30.

   b) Bring a **lunch** plus a couple of cans of pop. Don't pollute the environment. If no garbage bags are available bring left-overs back to the school garbage cans.

   c) Bring a **pencil and paper** for rough notes.

   d) **Safety** – if and when we are near machinery be careful. Full cooperation with any instructions is essential. Hard hats will be worn throughout the tour.

   e) **Weather** – hopefully it will be reasonable but a cancellation is a possibility. Listen to Tuesday's announcements.

   f) **Clothing** – dress for the weather. Outdoor footwear is desirable. The mill yards may be muddy. Shorts are not appropriate. Fly oil may be useful.

   g) **Smoking** – only during "breaks" as announced.

   h) **Tree planting** – everyone should plant at least one tree.

   i) **Your cooperation** is requested in making this outing pleasant and worthwhile.

2. **Reports**

   Each student is to hand in a report on what was observed during the tour. These are to be handed in during the class on Thursday. Put your name, class and date on top. Clip boards will be available for the tour – one for every two students.

3. **Questions to help with report**

   a) Nairn Sawmill

   - How is the wood delivered to the mill and how long is it?
   - What is the name of the machine that handles the wood?
   - What is the processor?
   - What length of logs comes out of it?
   - What lengths go to the Small Log Mill?
   - What lengths go to the Large Log Mill?
   - What is the debarker called?
   - What do the trim saws do?
   - What is the basis for stacking the lumber in different piles?

- How is the lumber dried?
- To where is the lumber shipped?
- What happens to the wood chips?

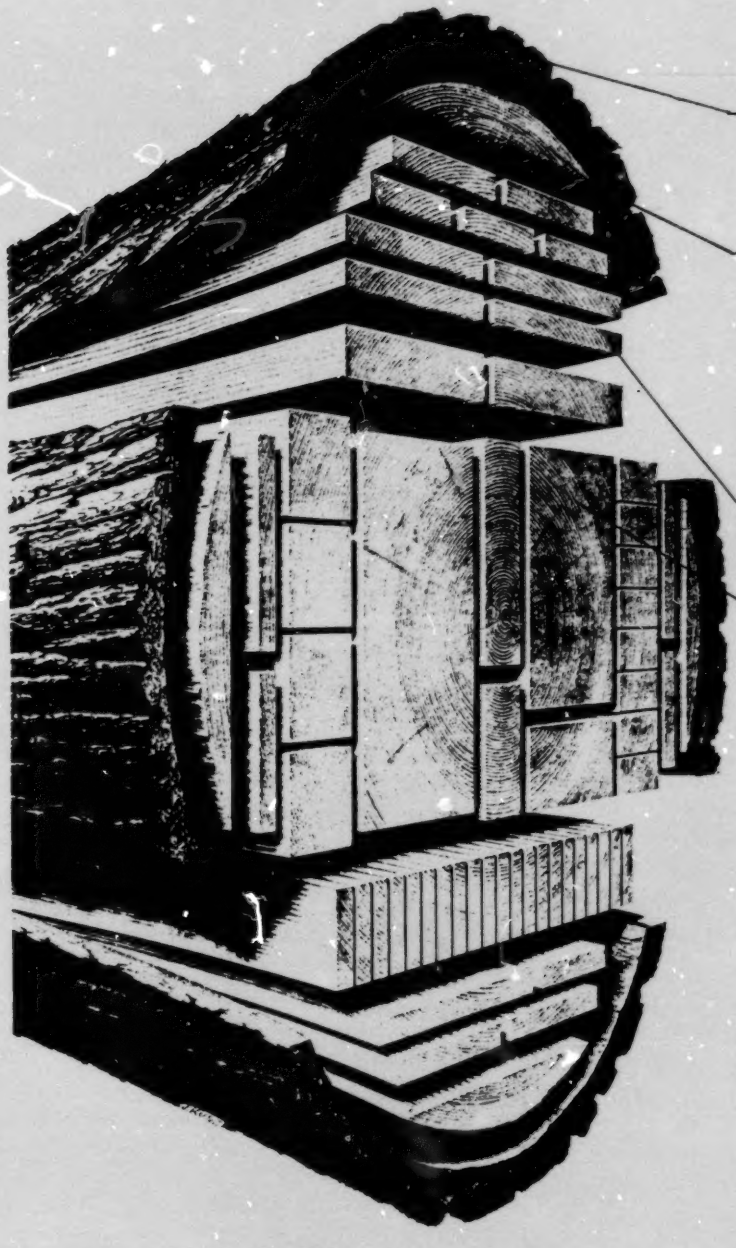
b) Nairn Plantation

- How has the thinning been done? What has been done with the slash (tops and branches)?
- How old do you think the plantation is?
- Is there evidence of natural or artificial pruning?
- How successful has the white pine planting been?
- What other tree species have been planted?

c) Menzies Mill

- What machines are in the mill? List them in the right order noting what each does.

LOG UTILIZATION



courtesy St. Regis Paper Co., New York

HOW THE BIG LOG IS USED

Debarking the log is essential to its full utilization because bark cannot be used for paper-making and therefore any piece dropped in the chipper has to be free of bark. The bark can be used for fuel and soil mulch.

The rounded sides of the log called 'slabs' are the first pieces sent to the chipper as the log comes through the sawmill. This idealized picture shows the full log being used for lumber except for the slabs. Actually, as cutting continues, other pieces go to the chipper including edgings, trim ends and other parts of the log not used as lumber. Each log presents different problems and can be handled differently.

The outer portions of the log have the fewest knots. This clear lumber is usually made into boards or planks varying in thickness from one to three inches.

Towards the centre of the log knots increase and the wood is less suitable for boards. Heavier planks and square or rectangular beams are normally sawn from this portion of the log. The centre of the log is used for structural beams strong enough that they are not weakened by the knots. Knots are most frequent here because this is the oldest part of the tree. Branches that were removed during the early years of the tree's life left knots that were covered over as the tree grew outward.

Plywood is in effect a wooden sandwich of thin wood veneers. Veneer is made by peeling the log against a long knife as the log is turned. The wood is continually peeled off down to a small core which is then treated as a small log at the sawmill.

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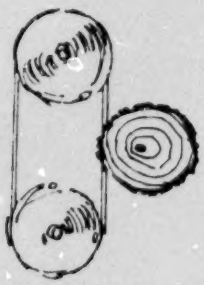
a) **Sawmill Parts**

A **jackladder** is a sloping ramp with an endless chain moving around a series of rollers. On the chain are teeth-like projections on which logs are held by gravity as the chain moves up the ramp from the log pond to the mill.

The **log carriage** runs on tracks and holds the log while boards are sawn from it.

The **headsaw**, a large circular saw or a band saw, cuts boards off the log. These boards are fairly rough on all sides and may be sold as **rough lumber**. In some mills the work of the headsaw may be done by one or a combination of circular, band and gang saws.

Band Saw



Gang Saw

The **band saw** is a toothed ribbon of steel running over two large wheels which keep it stretched tight and moving. A **gang saw** consists of a frame containing several saws which moves up and down and cuts out a number of boards at one time.

The **edger** consists of saws which square the sides of the rough sawn board and give it the desired width. This is accomplished by adjusting the position of one or a pair of edger saws.

Trim saws or trimmers square the ends of the board and cut it to the desired length. This is done by a pair of saws on opposite sides of a table. The length is obtained by moving the board ahead or back against an adjustable measuring device.

Sorting boards into **species, dimensions and grades** is done on the **sorting table** along which conveyor chains carry the lumber. From there the lumber is taken to the lumber yard for storage, to the kiln for drying or to a planing mill for further finishing.

b) **Drying Lumber**

Lumber has to be properly dried before it is used or it will shrink and warp. Drying helps prevent staining, improves the ability to be treated with paint or stain and reduces the shipping costs by removing the weight of water.

When wood is **air dried** outside in piles with spacing between the layers the air keeps taking the water away from the wood until the power of the air to do this is balanced by the power of the wood to take water from the air. At this point wood has reached its **equilibrium moisture content (EMC)**. The EMC varies with the season from about 12 to 20 percent in Ontario.

Drying can be achieved in a matter of hours when a **drying kiln** is used. This is an enclosure in which temperature and humidity are controlled by heat, steam and moving air.

Wood starts to shrink when the free water inside the cells and vessels (tubes) is gone and the cell walls start to dry out. This point is called the **fibre saturation point (FSP)** and it is reached when the moisture content of the wood reaches about 25 per cent. Boards shrink more across the width than in length. Why do doors and windows and drawers sometimes stick?

Two methods to find
the moisture content of lumber

i) **Electric moisture meter** – Perfectly dry wood is a non-conductor of electricity but damp wood will conduct a small amount. An electric moisture meter measures the current flow between two terminals and this is read on a dial as the moisture content of the wood.

ii) **Weighing a wood sample** – A sample piece of wood is taken from within the board, weighed wet, then weighed oven-dried.

$$\text{Moisture content} = \frac{\text{wet wt} - \text{oven-dry wt} \times 100}{\text{oven-dry wt}}$$

eg. wet weight = 120 g.
dry weight = 80 g.

$$\text{m.c.} = \frac{120 - 80}{80} = \frac{40}{80} \times 100 = 50\%$$

c) **Lumber Grading**

Lumber is **graded** according to the number and size of defects. The use to be made of the wood is taken into consideration. Different grades are suitable for different uses depending upon strength, nail-holding and painting ability, cost and other features. Grading of lumber is a complex matter and will not be covered here in any detail.

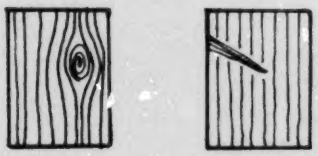
Do not confuse grading lumber with cruising or scaling.

Lumber defects with which students should be familiar are:

i) **knots** – branches overgrown with wood

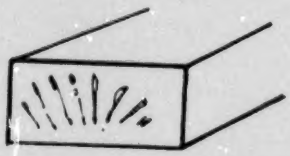
– "sound knots" are firm

– "loose knots" fall out

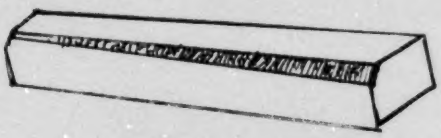


ii) **shake** – a separation between growth rings due to frost, wind, or growth deficiencies

iii) **checks** – splits in lumber caused by unequal shrinkage of the surface and core during drying



iv) **wane** – waney lumber has one or more edges of bark or sapwood from which the bark has fallen off. The edge is rounded, not square.



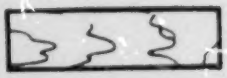
d) **Grain**

The grain in wood is the result of annual rings in the tree from which the wood is sawn and the manner in which it is sawn. Two types are of particular interest:

i) Flat sawn (or slash grain)

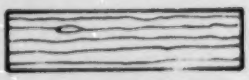
– has church door pattern

– cut tangentially on the log, parallel to the rings.



ii) Quarter sawn (or edge grain)

– cut at right angles to rings
– good for flooring, wears well, more thick walled summer-wood cells, does not sliver.



e) **Planed Lumber**

Rough lumber from the sawmill may be "planed", "dressed" or "finished" on one or more sides in a planing mill where machines with "cutting heads" consisting of knives set in round or square metal blocks that revolve at high speeds cut a thin layer of wood from the board as they are mechanically force-fed through the planer.

Reasons for planing

i) to obtain a smooth surface
ii) to obtain a uniform dimension
iii) to reduce weight in shipping lumber.

Lumber may go to the planer from either the sawmill, yard or drying kiln. When planed the lumber will be slightly smaller than rough lumber.

f) **Measuring Lumber In Board Feet**

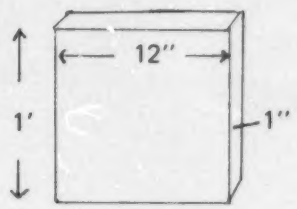
As noted in the material on scaling there are still uses being made of board feet measure in the lumber business. Measurement of lumber is one of the areas in which this occurs in some instances and students may find it useful to be familiar with the practice.

Board feet = bd. ft. = fbm (foot board measure) = B.M. (Board Measure);

$$= \frac{\text{Thickness (inches)} \times \text{width (inches)} \times \text{length (feet)}}{12}$$

$$= \frac{T'' \times W'' \times L'}{12}$$

$$1 \text{ Board foot} = \frac{1'' \times 12'' \times 1'}{12}$$



Problems

How many board feet in:

a) 1 piece of lumber 1" x 4" – 16'?

$$\frac{1 \times 4 \times 16}{12} = 5.3 \text{ bd. ft.}$$

b) 25 pcs (pieces) 1" x 4" – 18'?

$$25 \times \frac{1'' \times 4'' \times 18'}{12} = 150 \text{ bd. ft.}$$

c) 36 pcs 4" x 8" – 12'?

$$36 \times \frac{4'' \times 8'' \times 12'}{12} = 1152 \text{ bd. ft.}$$

Note that the dash before 16', 18' and 12' is not a minus sign. It is customary to use the dash before the length figure.

Where the pieces all have the same thickness and width but different lengths the board foot volume can be calculated by the **Lineal Foot Method.**

Find the total number of lineal feet (total length of all pieces in the pile) and use the board foot formula.

eg. 20 pcs. 2" x 9" – 8' = 160
25 pcs. 2" x 9" – 9' = 225
32 pcs. 2" x 9" – 10' = 320
705 lineal feet

$$\frac{2'' \times 9'' \times 705}{12} = 1057.5 \text{ bd. ft.}$$

Find the total number of board feet in this pile:

25 pcs. 2" x 8" – 8' = 200
25 pcs. 2" x 8" – 10' = 250
45 pcs. 2" x 8" – 12' = 540
51 pcs. 2" x 8" – 14' = 714
1704 lineal feet

$$\frac{2'' \times 8'' \times 1704}{12} = 2272 \text{ bd. ft.}$$

5.9 PULP AND PAPER PROJECT

References: 1. Booklet "About Pulp and Paper" from Canadian Pulp and Paper Association. (Return booklet upon completion of the project.)

2. Flow chart of Kraft pulp and paper process (see page 117).

3. Other publications from library, etc.

Deadline: To be completed by _____
You will be given 2-3 periods in class but plan on doing the rest on your own.

Value: Will be marked out of 25.

Instructions: Include a cover page with title/your name/class
Use paragraphs, lists, point form, etc.
Do not crowd information -- include good spacing
Underline headings
Think about what you are doing -- search out the answers.

Content: A. History of Paper

What was used before paper? By cavemen? Babylonians? Greeks?
Describe how the early Chinese made paper.
Outline the development of pulp and paper in Canada:

a) Give details about **the first paper mill**
b) Where was the **first paper-making machine?**
c) Where and when was the first mill making paper from wood?
d) What **two moves by governments** in the early years of the 20th century resulted in a great pulp and paper mill expansion in Canada.

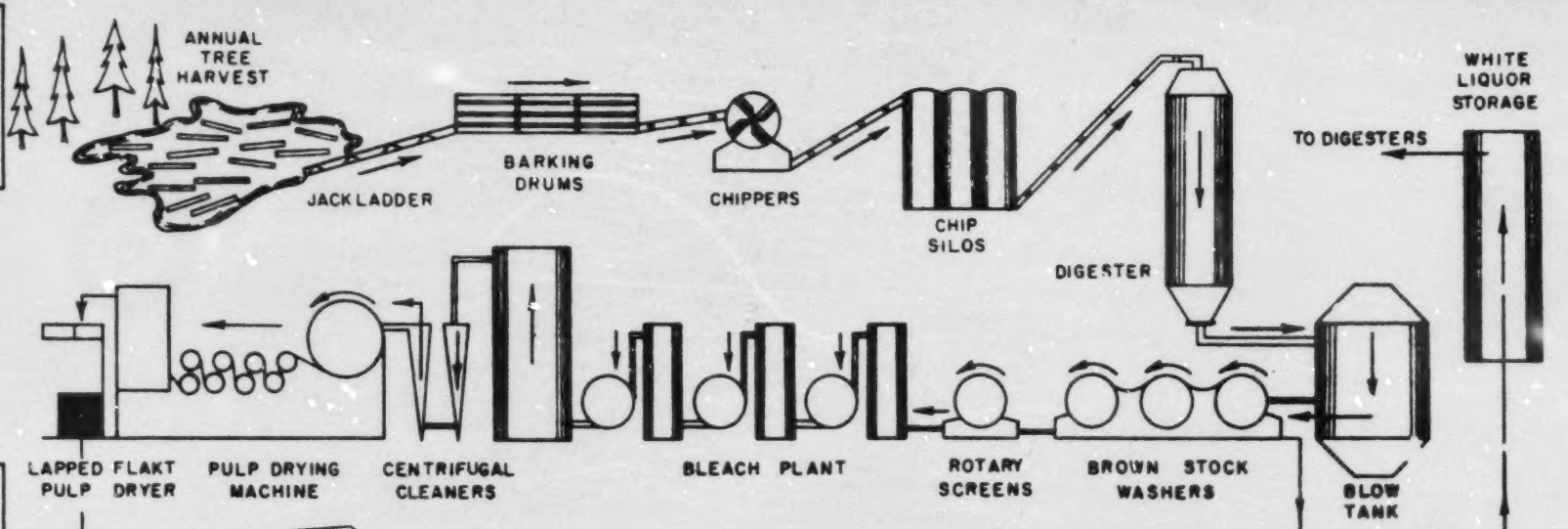
B. Pulp and paper mills

Refer to flow chart How Newsprint is Produced (middle of booklet) and preceding page. Note that after wood storage the **chemical pulp process** goes to the right. The mechanical (groundwood) process goes to the left. The two meet at the proportioner before going on to the paper machine.

Describe each machine or process in table form. The set-up is shown below with the first three items used as examples.

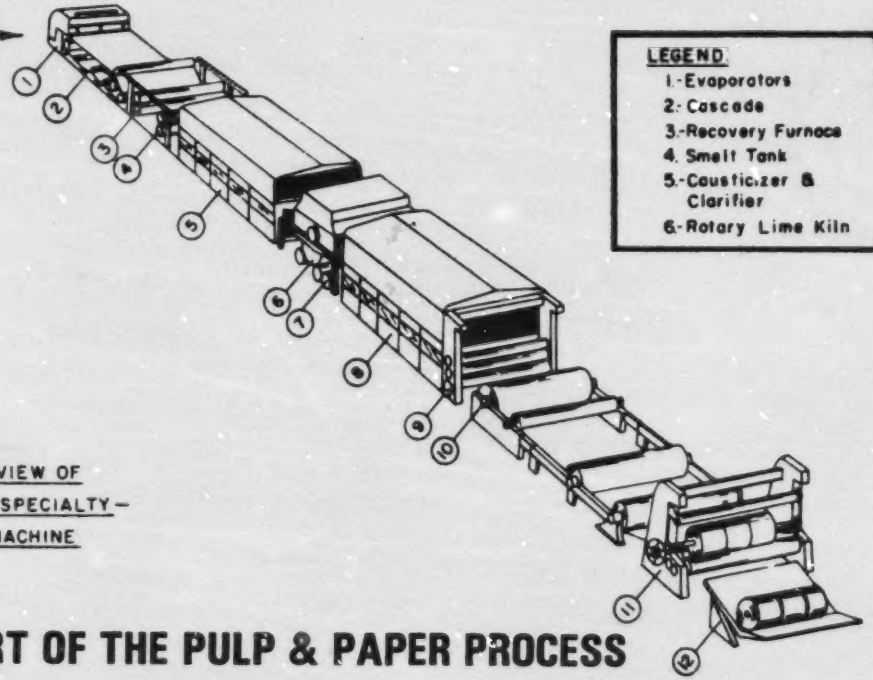
Machine or Process	Details
Wood supply	Purchased or from company operations
Barking	Drums or hydraulic barkers using streams of water to tear bark away

-WOOD-



-PULP-

-PAPER-



PROFILE VIEW OF
-THE KRAFT SPECIALTY-
PAPER MACHINE

LEGEND:
1.-Headbox
2.-Fourdrinier
3.-First Press
4.-Second Press
5.-Pre-Dryers
6.-M.G. Cylinder
7.-Size Press
8.-After-Dryers
9.-Calender
10.-Reel
11.-Winder
12.-Lowering Table & Rolls of Paper.

FLOW CHART OF THE PULP & PAPER PROCESS

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Wood storage	Blockpiles of pulpwood logs or chips.
etc.	etc.

C. Comparison of mills

Compare the flow chart in the booklet with that on page 117 of this manual using a table as suggested below. Note the main differences only.

Machine or Process	Newsprint Mill	Kraft (Sulphate) Mill
chip silos	chip bin	present
bleach plant	none shown	present
etc.	etc.	etc.

Of special significance is the presence or absence of the bleach plant, the groundwood process and the chemical recovery process.

D. Products

There are four broad groups of products. Name them. What happens to most of the pulp that is sold?

Name some products from highly refined wood pulps.

7% of newsprint is consumed in Canada. What happens to the rest?

What are two main products of paper board mills?

What are the finest grades of paper made from?

What kind of paper is used to make wrapping paper?

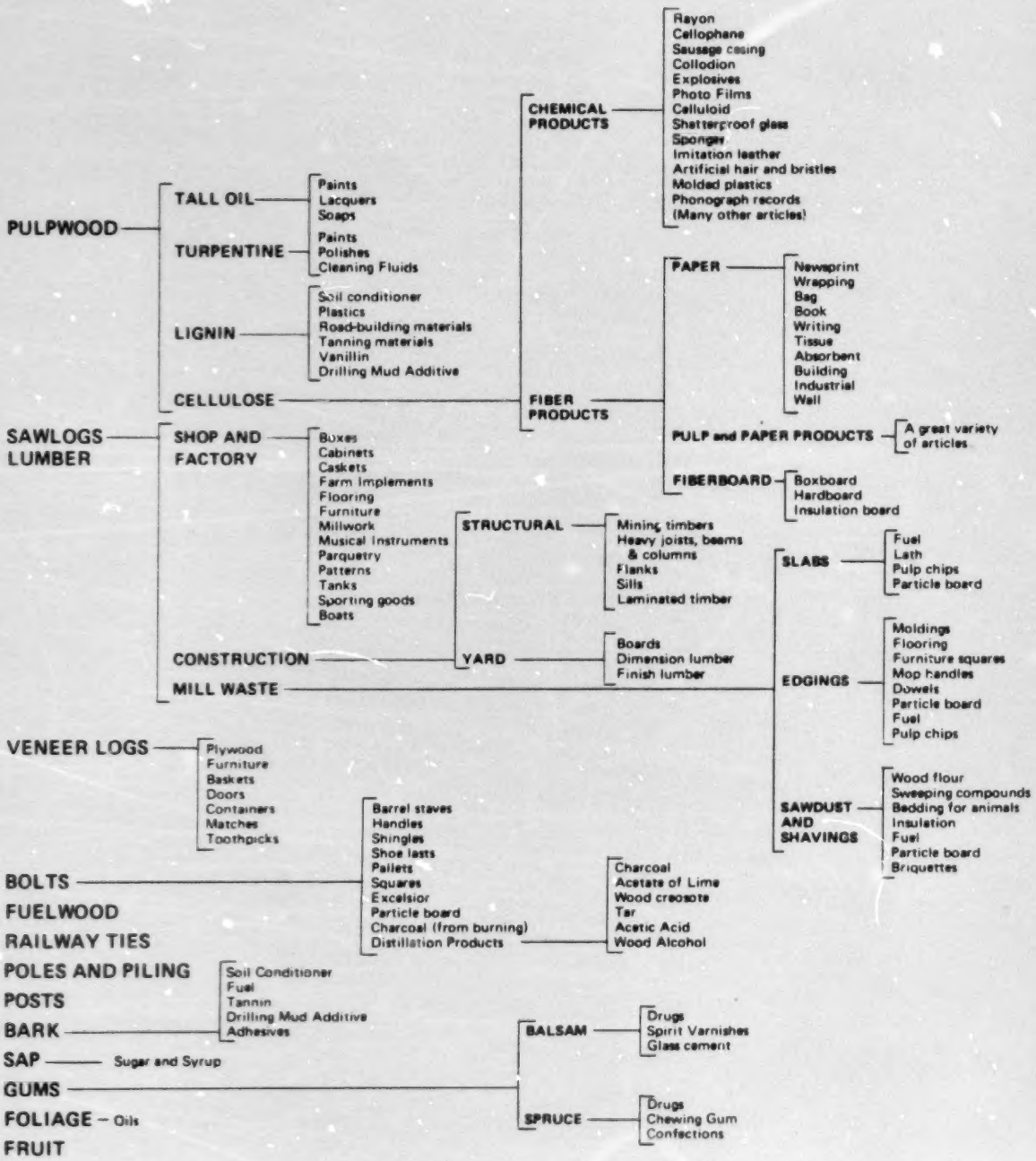
List some of the by-products from the pulp and paper industry.

E. Additional information

Add to your report by using material from the library or elsewhere. Additional information will be recognized when the project is marked. With the extra information include a **bibliography** noting the publication titles, page numbers, etc.

Conclusion: Don't put off completing this project until it is too late. START WORK NOW. Hand it in early if you can.

THESE PRODUCTS COME FROM CANADA'S TREES



UNIT 6
FOREST MANAGEMENT & SILVICULTURE

UNIT 6: FOREST MANAGEMENT & SILVICULTURE

OBJECTIVE

Students should be familiar with the main bases upon which forestry is predicated including manipulation of the growing conditions to favour particular species, understanding growth/harvest relationships, and public perceptions of forest management objectives.

6.1 TERMINOLOGY

There are many words used in forestry which have taken on meanings never intended. The following should be understood clearly by the student of forestry.

Forest management is the practical application of scientific, economic and social principles to the administration and working of a forest estate for specified objectives.

Silviculture is the science and art of cultivating (ie. growing and tending) forest crops and deals with establishment, composition, age class distribution and growth of forests. Its aim is to grow more and better wood. Silviculture is to forestry what agriculture is to farming.

Renewable resources are those things provided by nature to meet our needs and wants which can be used and replaced with careful management. Forests can be harvested and regrown. Wildlife populations can be renewed given proper food and cover. Soil can produce repeated crops if used carefully and water can be used many times over if properly used. **Non-renewable resources** such as minerals, oil and gas are not easily re-used or reproduced.

Conservation means the wise or intelligent use of natural resources. Such use permits their renewal and maintains their utility. Sometimes the word is used in the sense of saving, preservation and non-use.

Maturity has several meanings in forestry. It is a loose term for the stage at which a tree has attained full development, especially height, is in full seed production, and after which the tree begins to decline in vigour and health. It may be the age at which a tree or forest best fulfills the main purpose for which it was maintained. Economically it may be the stage when maximum economic wood production occurs. One of these stages, or all if they occur at the same time, may be the point at which a tree is cut for use as wood.

Rotation is the time it takes a tree or forest to grow from seedling to maturity or final cutting stage. This could be 60 years for pine pulpwood and 100 years for pine sawlogs. This applies particularly to even-aged stands.

Even-aged forests are composed of trees of the same or only slightly different ages (within 10-20 years). This is particularly common in our northern softwood forests which developed following fires and in plantations where the trees are planted at about the same time. Heights and diameters may vary.

Uneven-aged forests are composed of intermingled trees of many ages. This is common in southern Ontario hardwood and mixed stands. Young trees replace the older trees as they are able to grow in the shade of the others.

Cutting cycle is the period of time between successive cuttings in a particular area which implies that harvesting will occur on the total area in a prescribed sequence. In some stands this could be every year, every five years, ten years or longer. This usually applies in uneven-aged stands.

Sustained yield is the yield that a forest can produce continuously at a given intensity of management. New growth must replace losses due to cutting, fire, insects, disease, wind and flooding. To reach this goal a calculation is made for forest areas called the **annual allowable cut** (AAC).

Allowable Cut is the amount of material which may, over a stated period, be removed annually or periodically from a forest or of the annual or periodic area over which fellings may be made in accordance with the treatment prescribed. It is also referred to as yield determination. Simply stated the AAC is the average amount that can be cut every year from an area so that new growth balances the losses.

Allowable cut and bank interest

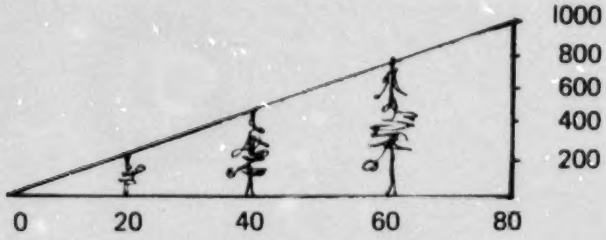
If you have $100. in the bank and use only the interest you can keep taking the interest and using it year after year. If you use the $100 (the capital) there will be no interest annually and your wealth may be short-lived.

Forests are like that. Even better than that. The forest stand is the capital and the new wood added each year is the interest. Keep the forest growing and a certain amount can be taken from it each year. If the forest is cut out and not replaced there will be no growth and no yearly harvest of timber. You will lose out, too, on the scenery, wildlife habitat and environmental protection benefits of the forest.

6.2 CALCULATING ALLOWABLE CUT

There are a number of ways to find the AAC. Some are very complicated. Two simpler basic procedures are the **volume method** and the **area method.**

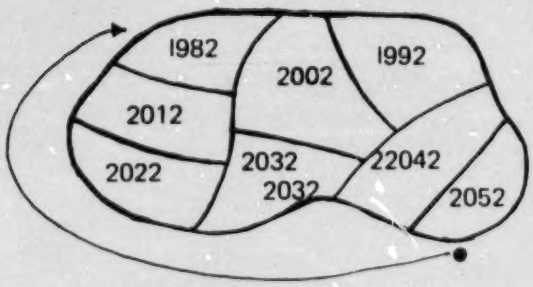
Volume method:- For the volume method to work the area has to have a fairly even distribution of trees at different age levels (age classes) ie. it is uneven-aged. If this condition does not exist the area method is preferable.



80 year rotation
Net growth - 1000 m^3/ha
Annual growth = $\frac{1000}{80}$ = 12.5 m^3/ha
5 year cycle - 5 x 12.5 = 62.5 m^3/ha

This indicates that a volume of 62.5 m^3/ha could be harvested from the total area on a 5 year cutting cycle.

Area method:-



The same forest in the volume method example above could be divided into blocks and the **total volume** removed from one of the blocks in each cutting cycle rather than removing it in small quantities from all over the forest.

This is particularly appropriate in **even-aged stands** where the growth is uniform.

The first area cut in 1982 should have a forest upon it when the last of the 8 blocks is cut in 2052.

Simple as this sounds there are, of course, some complications to consider such as aging of the crop on the areas not due for cutting for many years, disastrous forest fires, etc.

6.3 FOREST MANAGEMENT PLANS

(Do not confuse these management plans with Forest Management Agreements (FMA's) which are outlined next.)

If a forest area is to be managed in an orderly way, on a continuing basis, there has to be a plan. When companies have timber licenses on crown lands they are required to prepare **management plans** for the approval of the Ontario Ministry of Natural Resources. Other crown lands, that are not under license, come under management plans prepared by the Ministry.

Forest areas are divided into **management units** which are supervised by 'unit foresters' on MNR staff. Every unit has its management plan which describes how it should be handled on a sustained yield basis.

Operating plans and annual plans form part of the longer term management plan.

Management plans –	usually cover a 20 year period
Operating plans –	cover, in more detail, operations planned in the next few years
Annual plans –	go into complete detail regarding the work planned for the coming year

Contents of a Forest Management Plan

General Description
- location
- physical features
- tree species
- area history
- area economy

Outline for Management
- objectives
- silviculture
- allowable annual cut
- operations
- multiple use
- forest protection

Forest Inventory
- cruise data
- volumes by species

Operating Plan
- details for next few years
- logging, reforestation, etc.

Annual Plan
- for coming year
- cuts, silviculture, etc.

Revision of Management Plan
- information up-dated, due to changes in market demand, fire, etc..

Appendix
- data, maps, tables, etc..

6.4 FOREST MANAGEMENT AGREEMENTS (FMA'S)

As with management plans, these agreements are for a **20-year period**, and are **renewable every five years**, provided the work has been done satisfactorily.

In recent years a number of large companies have signed agreements of this type with MNR. Basically they deal with the responsibility for maintaining forest productivity by making the operating companies responsible for forest regeneration on their license areas.

In the final analysis, the Ministry of Natural Resources bears this responsibility since it manages the province's crown land on behalf of its owners, the public. However, some of this obligation is transferred to the companies signing these agreements. And in the process, the Ministry assists in a number of ways, such as:

- providing access road financing
- paying for tree seed and nursery seedlings
- reducing the charge made for wood cut (stumpage charges) under certain circumstances.

6.5 PROBLEMS, PAST AND PRESENT

These plans and agreements contribute substantially to successful forest management. However, potential problems remain. Some of them have been around for a long time. For example:

Money – Whether its being done by government or industry forest management costs money and the benefits often seem to be a long way off into the future. Most people believe in planting trees. At the same time they probably think, or hope, that someone else will pay for it.

Where does the money come from?

- Governments that get their money from industry and taxpayers.
- Industry that passes its costs on to the consumer.
- The public that ends up paying either as taxpayers or consumers or both.

Government and/or Industry

Along with varying amounts of cooperation there has been a lot of "buck passing" between government and industry in the past, each blaming the other for lack of progress in forest management. It's a big topic.

6.6 MULTIPLE USE AND WILDERNESS

Multiple use involves managing a forest area so that it is used for a variety of activities rather than just one or two. In the process some activities may be considered to be more important than others and be given priority. This may be over long periods of time or only during brief seasons.

Activities that may be part of a multiple use program include camping, hiking, fishing, hunting, wilderness enjoyment and logging. If you think the last two are in conflict that is part of the problem.

Algonquin Park is a multiple use area in part with some portions reserved from logging. Quetico and Killarney Parks are wilderness parks in total. The multiple use versus wilderness issue has tended to focus on such parks and the setting aside of specific wilderness areas. The issues are many and our intention here is simply to present some of them for consideration. Students might be asked to list points for and against wilderness parks and for and against logging in provincial parks. One needs to consider the issues in the light of who raises them and why in addition to the merits of the issues themselves.

Example: **For and Against Wilderness Parks**

For:
- People need forest areas to get away from it all, to get back to nature.
- Wilderness seekers have rights, too.
- There's lots of room for loggers elsewhere and for those who want power boats, cars and modern conveniences.
- If forestry is practiced properly outside the parks there will be the timber needed available.

Against:
- Society can't justify setting aside huge forest areas for wilderness purposes; the economy can't afford it.
- The trees are going to die and fall over so why not log them?
- Most outdoors people want comfort with electrical hook-ups, showers, etc.
- There's a lot of wilderness in Ontario available without putting it in a park.

Example: Logging in Parks

For:

- If trees not harvested they'll die and wood will be wasted.
- Cutting out logging cuts out jobs.
- Only a little of the park is logged at any one time.
- Cutover areas provide new growth that is good feed for wildlife.
- Cutting can avoid sensitive areas to some extent.
- Cutovers regenerate and disappear in a decade or two.
- It takes a long time to grow trees and we need a lot of them.

Against:

- Cutovers are ugly.
- Logging disturbs the park atmosphere.
- The second forest is liable to be inferior to the present one.
- etc., etc.

It is apparent that there are at least two sides to these questions and some truth in each position. Trade-offs are necessary to resolve the issues. The concern is that the trade of something in which you have no economic or historic stake may be much easier than the one on which you have built a business, enjoyed for years or counted upon for the future expansion of your activities. What ranking is given to the vote of the local person as opposed to one hundreds of miles away?

The Caterpillar Tractor Company advertisement states: "There are no simple solutions, only intelligent choices." Hopefully various sides can accept reasonable compromises and then live with them.

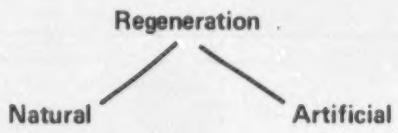
ACTIVITY: A Land Use Project

Divide the class into groups of six to ten students. Provide each group with a map and a target for wood production, wildlife, recreation, tourist establishments, roads, a town, an airport, hydro lines, a gas pipeline, parks, farms and other establishments of your choice. Give the students an opportunity to choose their roles as a forester, wildlife biologist, naturalist, park manager, tourist outfitter, farmer, airport planner, etc. Ask them to make notes in their discussion groups of the pros and cons of their various land allocations. Did they recognize the need for and value of multiple use? This can be a very lively exercise.

6.7 SILVICULTURE

Silviculture is the science and art of growing and tending forest crops to obtain more and better benefits from forests **including wood**. It is to forestry what agriculture is to farming.

a) **Regeneration** is the renewal of a forest crop by natural or artificial means. It also refers to the new crop so established. Logging and fire frequently precede regeneration.



i) **Natural regeneration** occurs when young stands start growing naturally from seed or as "sucker/growth" in which new shoots sprout from roots or stumps as is often the case with poplar trees.

Advantages: If nature does the job on its own it is inexpensive.

Disadvantage: Too often the "regen" is not satisfactory. Too little, too much, too poor, or the wrong tree species may grow.

ii) **Artificial regeneration** (reforestation) starts a new forest using either **seeds** or **seedlings**. This method usually aims to regenerate areas in which nature has failed to produce a satisfactory crop of new trees.

Advantages: Species wanted can be planted.

Number of seeds or seedlings can be controlled.

Faster, more reliable than Nature.

Disadvantages: Expensive – planting is not cheap.

Tend to be in monocultures (one species) with attendant risks of fire, insects, disease.

Hard to predict markets for 80-100 years hence.

Site preparation may also encourage competition from grass, brush and unwanted species of trees.

Drought, improper planting, mice, birds or wrong soil/species relationships can prove costly.

b) **Care and Planting of Seeds and Seedlings**

i) **Seeds**

Seeds are collected from standing trees or felled trees and sent to seed plants for cleaning and storage. They may come from cones (softwoods) or of other types (hardwoods) and may be sown directly by the use of "hand windmills", fixed wing aircraft or helicopters on areas to be regenerated. The use of aerial seeding with helicopters is becoming common in jack pine regeneration work particularly.

As many as 50,000 seeds per hectare may be broadcast. If the 'catch' is too good it may be necessary to thin the resulting stand later.

ii) **Seedlings**

Tree seedlings are grown from seed in forest nurseries. They may be grown in **containers** (tubelings) or **seed beds**. When they are ready to plant out those in containers can be moved as they are to the planting site. Those in the seed beds have to be lifted and transplanted to transplant beds or moved to their final growing place in the field. Those transplanted to transplant beds stay there one or two years to grow larger and more vigorous for planting out in the field.

Seedlings grown in containers from seed to planting are known as **container stock**. Those lifted and set out in transplant beds are **transplant stock** and those lifted and shipped directly from seedbeds or transplant beds are called **bare root planting stock**. To keep these seedlings alive and in good condition they are usually packed in boxes or bags with wet sphagnum moss and held in refrigerators until ready for shipping or planting.

Planting stock may be described by figures noting its treatment in the nursery:

eg. Pr 3–0 = red pine, 3 years in nursery bed, 0 in transplant bed.
Sw 2–1 = white spruce, 2 years in nursery bed, 1 in transplant bed.

iii) **Care of seedlings** – before final planting

When seedlings are being held in refrigerated cars or trucks caring for them is relatively simple. When they come in sphagnum unrefrigerated they need more prompt attention.

- plant seedlings as soon as possible upon receipt.
- keep roots protected from sun and wind (fine root hairs dry out quickly).
- seedlings can be kept for a short while in a cool place in the sphagnum if watered.
- seedlings can be stored longer if "heeled in" by placing the roots of bundles of them in a shallow trench, covering the roots with soil and watering them well.

iv) **Spacing of seedlings**

The spacing between seedlings varies. Common examples are:

2 m x 2 m
2 m x 2.5 m
2.5 m x 2.5 m

How many seedlings would be needed per hectare on such spacings?

v) **Planting control** can be achieved as follows:

- ploughed furrows
- planting crews in line, move ahead together
- planters may pace or measure distance
- strings may be used to keep lines straight
- in rough areas trees may be "spot" planted wherever there is sufficient space and soil. (Remember little trees grow big!)

vi) **Pay for planting**

Planting crews may be paid by the day or on a contract basis of so much per tree. The latter works well if the job is well supervised. If not there may be a temptation for planters to plant poorly or throw seedlings away when no one is watching. Planting 1000 trees by hand is considered a good day's work for the average individual. Machine planting increases the number to roughly 1000 per hour.

Four methods of hand planting with shovels

The planting method to use depends upon the type of soil and the ground conditions. It is always important to spread and pack the roots well to prevent them drying out after planting. These planting methods can be demonstrated and practiced during an outdoor class or field trip:

1. Spot planting — If the sod is thick throw back a square of it and plant in the soil beneath.

2. T-planting —Two cuts at right angles, pulling back on the shovel the second time to open up the slit in the soil.

3. Slit planting

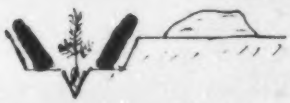
– On loose, sandy soil. Make one cut with the shovel, pull back on the shovel handle and drop the seedling into the slit.

4. Wedge planting

– With two cuts take out a wedge of soil place seedling roots against the flat cut, replace the wedge.

viii) **Machine planting of seedlings**

The planting machine is towed behind a tractor. A plough blade makes a trench and furrow and the planter places a seedling in the tranch. Two small rubber-tired wheels pack the trench edges together and pack the soil around the roots. The furrowing turns the sod over and removes plant competition. It also shields the seedling from drying winds. Machine planting is favoured in flat, open areas where the going is good and it is much faster than hand planting.



ix) **Container seedlings**

Keeping seedlings in the nursery is relatively costly and takes a lot of space. By growing seedlings in containers it is possible to move them to the field within one growing season in their original germination medium (soil in which they first sprouted.) Since they are small many millions can be grown in a few greenhouses.

There are several types of containers from plastic tubes to paper pots and plastic packages which open to leave the seedling in a plug of soil ready for planting without a container to break up or grow through as in the plastic tube and paper pot.

Container stock is planted in a variety of ways from aerial darts to dibbles with triggers which drop tubelings down a metal tube into a hole punched in the ground. A Finnish model of this device, a type of planting cane that pokes a hole into the ground and drops the seedling into it, is called a "pottiputki".

Advantages: Roots remain undisturbed in the container soil when the seedling is moved and planted.

Since container seedlings keep their roots in the soil planting can take place during the summer as well as spring and fall. Hot dry spells in summer may severely limit success of planting, however.

Container seedlings can be grown quickly and more cheaply than bare root stock.

Disadvantages: Frost action may heave containers out of the ground.

Seedlings are very small to compete with grass and bush. To lessen site competition it is often necessary to reduce competition by chemical or mechanical means.

c) Helping Natural Regeneration

Various things can be done to encourage natural regeneration. As these cost money they have to be compared with planting costs and success rates and a decision made as to which is best.

For some species, like poplar, a new crop comes in quickly from sucker growth. However, more valuable trees require two things to regenerate:

- an adequate **seed** source – this requires productive trees within a suitable distance.
- a suitable **seed bed** (ground) – conditions for seed germination and seedling growth must be right.

Seed source – Many trees produce a heavy crop of seeds every so many years. Some pines have a "**seed year**" every four or five years and many cones can be seen on pine trees in that year.

With most conifers the cones open and the seeds fall to ground. They are spread by the wind to some degree. Jack pine, however, is an exception. With this species the cones only open when heat is present. This is usually provided by the heat of sunlight on the ground or by forest fires. Most jack pine stands are the product of forest fires and are even-aged. While the fires have successfully produced good natural regeneration the original stand was lost in the process. Prescribed or controlled burns may be used to burn jack pine cone-bearing slash on the ground after a logging operation as a means of opening the cones and providing seed. Judicious logging can also help increase the supply of seed available for natural regeneration.

Seed bed – Some tree species require **bare soil** for the seeds to germinate and take root. This soil exposure may be achieved by fire or the action of logging machinery. The soil in cutover areas may be exposed by **scarification.** In this process various types of heavy scrapers (scarifiers) are dragged behind a tractor to rip up the vegetation and slash to expose the soil. A new approach is looking at power heads on scarifiers to reduce the energy requirement of dragging chains, barrels, and other scarifying devices. Again, this costs money and there has to be a seed supply. Logging can also be done in such a way to encourage production of a suitable seed bed.

i) **Prescribed burns to aid regeneration – these are fires set intentionally to 1) get** rid of unwanted logging slash, 2) to improve seedbed conditions, 3) to get rid of unwanted growth and 4) to open jack pine cones. These fires have to be set under controlled conditions and there is the problem that when it is dry enough to burn well it is also dry enough to be dangerous. It is common practice in the southern United States to run a ground fire through pine plantations to destroy hardwood growth that struggles up through the pine. Slash disposal by fire is common in British Columbia and fire is used as a silvicultural management tool in site preparation in many countries. Ontario uses it to some extent. It is an economical and effective treatment if it can be controlled. Prescribed fire can be a generous aid to natural regeneration in the manners described.

ii) **Cutting methods to aid regeneration**

Trees can be harvested in various ways with costs, growth, utilization and regeneration as important considerations. The four principle methods are outlined below. Not all are suitable in all stands due to characteristics of the tree species themselves.

1) **Clear cutting method**

All or most of the trees are removed in one operation. This method is the **simplest and cheapest** and is the common one in operations in the even aged stands of northern Ontario. The size of clear cuts and the provision of wildlife bridges of green cover across them prompt discussion.

Advantages: Appropriate method in even-aged stands.

Simple to plan.

Easy to reseed or plant.

Cheapest in terms of wood harvest, road building, etc.

Useful to some forms of wildlife as it grows up again.

Disadvantages: Unwanted species may be left to die or regenerate the cutover.

Regeneration may be unsatisfactory.

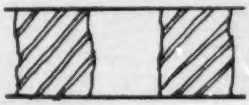
Soils may be subject to intense heat and erosion.

Drying winds may modify the site.

Wildlife habitat may be altered adversely.

Possible solution:

Cut in strips or patches leaving forest around the patches or strips to seed in the open areas after which the remaining forest can be harvested.



2) **Seed tree method**

In this method the forest is clear cut in patches except for scattered, superior trees or groups of trees left to provide seed for the area. The trees may or may not be harvested following satisfactory regeneration.

Advantages: Simple and relatively inexpensive.

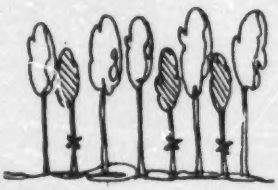
Disadvantages: Trees may be blown down.

Trees are valuable during first cutting but may be uneconomic to harvest later.

Seed year may not occur while the ground is in a suitable state to receive the seed.

Too little seed may germinate to cover the area adequately.

3) **Shelterwood method**



With this method an even-aged forest may be harvested in **two or more cuts.** The first cut takes out the poorer trees and improves the spacing between those that are left. The latter increases the growth rate on the remaining trees and opens up the ground area for natural regeneration. Some years later the final cut takes out the mature trees.

Advantages: Makes full use of wood growth.

Encourages better growth on remnant trees.

Encourages regeneration of some species.

Disadvantages: More costly.

Trees must be marked for cutting.

Logger must return to the site a second time.

Damage to remaining trees may be high unless carefully done.

4) **Selection method**

This method applies generally to uneven-aged (all-aged) stands. It involves cutting on a regular basis or cycle. Mature and defective trees are cut leaving the best nearly-mature and young trees to grow under optimum spacing conditions.

Advantages: Provides an opportunity to improve the growth of trees that have already shown promise.

Encourages regeneration of good quality material from superior parent stock.

Utilizes the full growing potential of the area.

Permits favouring of species desired.

Disadvantages: Going back to the same area for small volumes may be too costly and inefficient.

Trees for cutting must be marked (could be costly).

Damage to standing trees must be avoided.

d) Tending the Forest During A Rotation

It may be fine to plant an area with seedlings but that is no guarantee that a reasonable number of trees will reach manturity. Planting or natural regeneration is just the start. The crop must be tended if it is to reach maturity. Among the requirements are:

i) **Protection**

From fire, insects, disease, animals, wind, etc. More on this in Unit 7.

ii) **Control of competition**

Grass, bushes, or other trees (eg. poplar and birch) too often choke out young conifer stands. Spruce may fight its way up through the competition but trees like red pine may die out completely. In some cases it may be wrong to try to compete with such fast growing competition. Ways to control competition include:

Cut it down This may be too expensive and it may grow back too fast.

Spray With brush control herbicides. Costly though cheaper than mechanical means. Subject to public protest.

Girdle Unwanted larger trees may be girdled with a chain saw, a girdling tool and/or chemicals. A strip of the bark is removed all around the tree cutting off the food supply to the roots. The tree dies as a result, drops out of the overstory and is no longer competitive.

iii) **Thinnings**

Some young stands have trees that are very close together. Some crowding may be good because it keeps trees growing straight and results in the natural pruning of the lower branches which die off in the dense shade. Too much crowding slows growth and puts growth on stems which will not be useful in the final crop.

Thinning opens up the stand for better growth and, in some cases, to encourage natural regeneration on the ground.

In some plantations whole rows of trees are cut out – every third one, for example.

In some forests only the poorer trees are cut leaving the better ones for a later cut. Spacing between trees is a consideration.

In young stands thinnings may be left on the ground to rot or they may be removed and burned. In older stands the thinnings may be sold as pulpwood or firewood.

iv) **Pruning**

Two kinds of pruning are recognized:

Trimming ends of branches for a better shape as in Christmas tree plantations.

Removing branches close to the tree trunk with saws or shears to yield knot free lumber. New wood will grow over the branch base.

6.8 WOODLOT MANAGEMENT

Private woodlots are an important part of the province's forestry picture and, to a serious degree, they are under-managed. Advice and assistance in this regard is available from the Ministry of Natural Resources, forest industries, the Ontario Forestry Association and others. As mentioned elsewhere woodlot management is encouraged by various tax incentives.

Project possibilities

A study of woodlot management is a worthwhile undertaking and it can take the form of reading, discussion, or an essay.

Publications on the subject are available from the sources mentioned above.

6.9 HYBRID POPLARS

Hybrid poplars are the result of "tree breeding" in which certain desirable properties are obtained by crossing different varieties to produce the hybrid.

Poplars normally are fast-growing trees, and the hybrids are being worked with in order to improve the growth rate and to get better fibre quality, etc. Projects of this type are currently being undertaken in Eastern Ontario and elsewhere. The hope is that they will provide a good crop of trees on land that is poor for farming. Hybrid poplar production is a successful operation in parts of Europe.

If successful, hybrids might provide the following:

- A cash crop in two years. Biomass for energy, etc.
- In ten years, a fibre crop (pulpwood).
- In twenty-five years, veneer logs.

6.10 DOES FORESTRY PAY?

Students might be asked to list points on both sides of the question or to write an essay on the subject. Perhaps a discussion would be preferred. Some points supporting forestry are presented (p. 140) as answers to negative statements that might be made.

a) **"I'll be dead by the time these trees are ready to cut."**

Keep the following in mind:

- an area with young trees is worth more than one covered in brush and weeds.
- a plantation in 30 years can produce thinnings which may be sold for pulpwood, fuelwood, etc.
- your children and the next generation will benefit if they inherit a thriving forest.
- while you are waiting to harvest a crop the trees will add beauty to the area, fight erosion, provide shelter for wildlife and maintain the water table.

b) **"If the money doesn't look good what is the point?"**

- if the forest or woodlot is already in good shape it can provide a potential source of income indefinitely into the future.
- there are some tax advantages for woodlot management.
- many people enjoy managing a woodlot for the pride and satisfaction they get out of it. For some it is a hobby, recreation, fresh air, exercise, a chance to get away from it all.
- fuelwood has become a significant sales possibility and benefit for home use.

c) **"At some time during the rotation the trees will probably be wiped out by fire, insects or disease."**

- forests can be protected in many ways, usually with a reasonable degree of success.
- it's a chance you take. Other investments have risks, too. Farmers have similar problems. When you are growing things you have to gamble with the weather, insects and disease. If no one took these chances we might end up without food or forests.

d) **"Spending money on forestry does not guarantee results."**

Right. Since forestry is so long run mistakes may get lost or forgotten. Unless that which is done is done efficiently it is probably too costly.

e) **"Others will do it."**

Everyone's responsibility becomes no one's responsibility. Unless everyone really gets into the act we may end up short of wood, with fewer jobs and less money.

UNIT 7
FOREST PROTECTION

UNIT 7: FOREST PROTECTION

OBJECTIVE

Forests require protection from three destructive forces – fire, insects and disease. In this unit students will receive a bare introduction to these three large and important topics.

7.1 FIRE PROTECTION

a) Forest Fire Prevention

It has been noted previously that not all fires are bad. The aim of forest fire prevention is to prevent those fires caused by human carelessness not those prescribed by foresters for management purposes.

About 80% of forest fires are caused by **people**. Most of the others are caused by **lightning**. Carelessness is a major factor and it usually involves the way smoking, campfires and burning debris are handled.

The rules that follow are rather well known and are basically common sense. The problem is that too many people get careless in applying them.

Basic Rules of Fire Prevention

Smoking

- sit down to smoke – do not smoke while walking in the forest
- use a lighter or make sure your match is out.
- crush all butts dead out.
- dispose of butts in the ashtray, not out the window.

Campfires

- select a safe place, near water, on a rock or on mineral soil. (The latter may require removal of the litter such as leaves, twigs, etc.)
- where possible surround the fireplace with rocks.
- make sure the fire is dead out before you leave it. Flood with water. Stir it with a stick. Bury it in sand if that is available. Check to be sure it is out.
- don't leave a fire unattended. (An unexpected wind could cause trouble.
- don't think it is out....BE SURE.

Debris or grass

- you may need a burning permit.
- burn in a safe place.
- avoid burning when it is windy.
- have fire-fighting tools ready.
- burning in the early morning or evening is best because it tends to be cooler, damper, and less windy at those times.

- where possible, do the burning in an incinerator.

b) Forest Fire Hazard Index

This is used to indicate the existing degree of fire hazard in a forest area. The four levels are -- **low, medium, high, extreme....** This information may be used for the following purposes:

To restrict forest travel during extreme conditions.
To ban burning during extreme conditions.
To provide a basis for maintaining fire crews and equipment at a certain level.
To be used as a guide as to how much fire-prevention publicity should be aimed at the public through the media. (This can be tricky at times; a hazard warning on the radio could occur during a downpour of rain.)

A fire hazard index is compiled using a formula that takes into account four things -- temperature, humidity, wind, and the number of days since the last rain.

This information is usually collected at **weather stations** located throughout the region. The equipment in these stations includes a rain gauge set up near a ventilated shelter that houses such things as a thermometer and a hygrometer; the latter to measure humidity. Readings are taken two or three times a day and reported to the fire protection office.

As well as weather data, there are a number of **other considerations** to be taken into account when assessing fire hazard such as:

- the presence of large areas of dry **logging slash.**
- the **type of forest.** In general, conifer stands represent a much higher fire hazard than hardwood forests. In the spring and fall when the leaves are dead on the ground, fire may burn through a hardwood stand with minimal damage.
- **ground conditions.** In the spring and fall there may be a period when the ground vegetation and needles are dry so a very high hazard condition exists. Once the green growth on the ground appears the situation improves and the hazard is less.

c) Three Types of Forest Fires

i) **Sub-surface (underground) fires** burn in the ground in thick deposits of moss and peat. They may smolder for long periods, occasionally right through a winter under the snow, then break out at the surface when the weather becomes hot and dry. To control them, a trench is often dug around them down to mineral soil. They then burn themselves out. Another possibility is to flood them out with water. There is special equipment available for this.

ii) **Surface fires** burn along the ground using litter, brush and young trees for fuel. At times they may burn up the trunk of an individual tree into the crown. This is called "torching".

iii) **Crown fires** may develop from surface fires in dense conifer stands. They move from tree top to tree top, often at frightening speeds. Burning embers are carried ahead of the fire by the wind, often starting "spot or jump" fires. Crown fires are the most difficult to control.

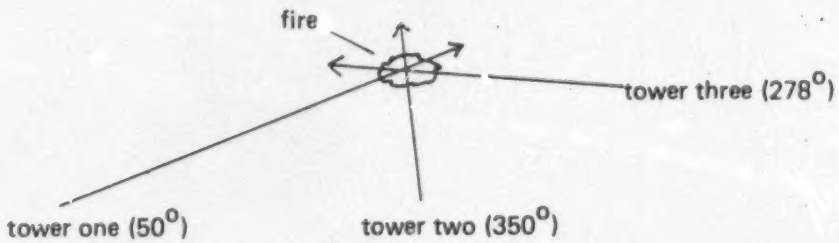
d) Forest Fire Detection

The general public is one of the main fire detection units and reports a high percentage of the fires each year.

In the past a **fire tower system** covered Ontario forests. (Some provinces still use it.) This system has now been **replaced by aircraft patrols** which maintain radio contact with headquarters.

When towers were in use the towerman in each tower would get a bearing on a fire and transmit this information to headquarters where all the bearings being reported were plotted on a map. Where these bearings intersected gave the fire location.

Example:



Ray Gun Probe-Eye Unit

This device may be a small, hand-held unit or a large mounted unit in an aircraft. It is an **infra red scanner** that is so sensitive to heat that it can detect a burning cigarette at 20 metres. Another indication of its sensitivity is the fact that it can pick out airport runways because of the different heat reflections from the pavement compared with the surrounding grass. The value of these ray guns in forest fire detection is obvious. They can be used from the ground or in a helicipter along a fire line to search out hidden fires. The large units may be mounted in aeroplanes for detection purposes making fire patrols more effective.

e) **Forest Fire Fighting (suppression)**

A critical objective in fire-fighting is to get to the fire while it is still small. Control then is relati easy. Once a fire becomes large it is extremely difficult to control **unless** weather nditions enter the picture in a favourable way giving the fire-fighters "a break". It can be argued that spending a lot of money on big fires is wasteful. However, unless men and equipment are in place and ready to move shou'd the weather provide a control opportunity, large fires might go on for much longer periods. Property threatened by fire can often be saved if men and equipment are available.

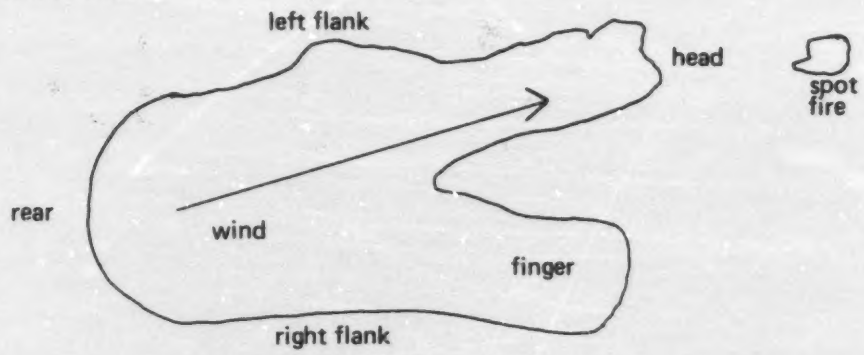
Fire fighting is much more effective in the early morning or during the evening than it is in the middle of the day when heat and wind often are at their peak. Morning and evening activity benefits from dew, cooler temperatures and usually less wind. Working at night may have similar advantages provided lamps, etc., are available for moving about the forest in the dark.

Fire fighting is done with **ground crews**, trucks, **aircraft**, pumps, hose, camps, radios, food and a host of other **equipment** items. Ontario maintains a number of **attack units** of five men each equipped and ready to go to a fire on short notice. The province maintains a fleet of aircraft equipped for **spotting** fires, **carrying** fire fighters and equipment to them and for **bombing** fires with water or chemicals. Many of the planes load their tanks with water by skimming the surface of a lake or river. With **small fires** the bombing dampens and "cools" the fire holding it in check until ground crews can get to it to put it "dead out". On **large fires** the water bombing may be restricted to the head of the fire to slow down its advance or the flanks may be watered to aid ground crews in controlling the fire or its direction of travel. Fire retardant chemicals which adhere to the trees and slow fire may be used and "wetting agents" may be added to water to reduce its surface tension and thus make it more penetrating.

Ground crew equipment

- Power pumps and hose.
- Pack pumps, either metal or canvas. With the metal ones, they can be kept full of water, ready to go. With the canvas type, they are easier to take to the fire empty, in a collapsed condition.
- Shovels, rakes, and specialized hand tools.
- Back-fire torches, etc.
- Under certain circumstances, ploughs and bulldozers are used in fire line construction.

Basic parts of a fire



Fire lines

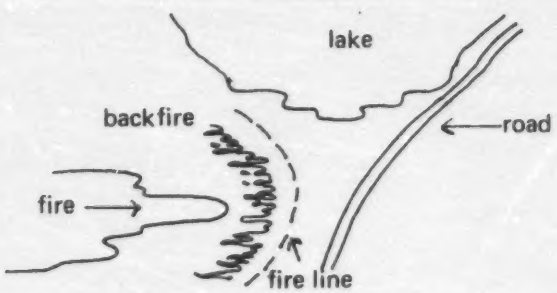
Fire control usually involves the **construction** of a fire line around the fire or along its flanks. These lines are scraped down to mineral soil in an effort to contain the fire and once established have to be patrolled to keep the fire within the boundary. In due course the fire within the line burns itself out or is extinguished by fire fighters.

If a fire is not moving too fast the line may be built across its front. Otherwise it is built along the flanks in an attempt to pinch it off or to direct it into an obstacle such as a road, lake or hardwood bush where control may be more successful.

Within the fire line "**hot spots**" are controlled by water or covered with mineral soil. Burning pieces are broken up using axes, shovels, etc.

Backfires

Backfiring is an indirect attack; fighting fire with fire. It involves constructing a fire line well ahead of the fire then starting a fire (using torches) that burns its way towards the main fire consuming the fuel as it goes. This method may be the only hope of controlling some big fires but it should only be undertaken by experienced people. The danger is that the backfire may get out of control, too, due to wind shifts, jumping the fire line, etc..



7.2 INSECT PROTECTION

While less spectacular than forest fires insects often cause greater losses. More information about insects can be gained from the Great Lakes Forest Research Centre, Canadian Forestry Service, Box 490, Sault Ste. Marie, Ontario, P6A 5M7.

Our study of this aspect of forest protection is restricted to three insects and a look at the spray or not to spray issue.

a) The Forest Tent Caterpillar ("army worms")

Despite the name the forest tent caterpillar does **not** build a web tent. The eastern tent caterpillar does.

Identification differences:

FOREST TENT CATERPILLAR

- Does **not** build a tent. Clusters in masses on tree trunks and branches.
- The larva (caterpillar) is dark brown, with a broad blue band along each side.
- There is a **row of white, key-hole-shaped spots** down the center of its back.

EASTERN TENT CATERPILLAR

- Builds a web tent in bushes, etc.
- The larva is black, with a **white strip along the back.**

Damage

The forest tent caterpillar eats the leaves of poplars and other deciduous trees. It seldom kills the trees. However – the trees are weakened and this results in less growth and more disease activity.

Life Cycle

- In midsummer the female **moth** encircles a twig wit[illegible]band of eggs.
- Next spring the small caterpillars emerge and feed in colonies (groups).
- After 4–6 weeks and **molting** four times the larvae spins **cocoons** from which the adult moth emerges.
- Mating takes place, the **eggs** are laid, and the cycle starts again.

Heavy outbreaks may occur every ten years and last for three to six years.

Controls

Natural control may result from **starvation** or from attacks by more than forty types of **parasites.**

If only a few, on ornamental trees, they can be picked off. Some people wrap the base of a tree in aluminum foil or grease, to prevent the caterpillars from climbing the tree from the ground. Insecticides may be used.

b) The White Pine Weevil

White pine trees may be attacked by the white pine weevil.

Life cycle

The adult weevil spends the winter in the ground. In the spring the **eggs** are laid in the lead (top) shoots of the trees. When they hatch the larvae tunnel beneath the bark killing the lead shoots. As a result the trees become deformed with forked and crooked branching.

Weevilled lead shoot

Resulting branched top

Controls

Weevil attacks on white pine take place mainly in open conditions such as those found in young plantations. In shaded conditions under an overstory of older trees the weevils are not a problem. Underplanting white pine seedlings, under a tree crop that will die out as the white pines grow large, is a possible solution. Trees that have weevils can be hand-pruned and the dead or dying material burned to kill the larvae inside and prevent population build-up. Stomach poisons can also be used (with care) at 3 or 4 year intervals until the trees reach 10 metres or more in height.

White pine is an excellent tree and the wood is useful for many purposes. It has played an important part in our history.

c) Spruce Budworm

Spruce budworm is currently **the most serious** insect menace in Canada. It threatens the spruce and balsam fir stands of Eastern Canada. **In addition** to killing the trees the miles of dead slash and stubs that remain represent an explosive concentration of forest fuel should a fire get started.

Life cycle

The adult budworm is a **small brown moth** which appears in July. After mating the female moth lays its **eggs** in clusters on the underside of spruce and balsam needles. The tiny **larvae** hatch and spend the winter in twig and bark crevices. In the spring they mine into needles or unopened buds and then the new needles. After five to seven weeks the larvae become **pupae** from which they emerge as adult **moths**.

A budworm moth may travel up to 80 km using downwind flights. Controlling its spread is a problem.

Controls

Since the budworm damage is most severe in mature and overmature spruce and balsam stands control **through forest management** may be attempted by harvesting these mature stands before they are attacked. There are practical difficulties in this regard such as the widespread nature of the attacks, costs involved, the limits of market demand and the proportion of the existing forest in an overmature condition.

Many provinces are using **aerial spray programs** to control spruce budworm populations. These do control the situation but do not cure it. The application of these sprays is controversial.

d) To Spray Or Not To Spray

This topic is a matter of continuing debate and there is some truth on all sides of the issue plus a lot of uncertainty. New Brunswick has the longest experience in spraying for spruce budworm control and is still spraying. In addition to the chemicals used biological control is being attempted.

Students might be asked to discuss the matter on the following basis: Suppose you were the Minister of Lands and Forests and you had to make a decision for or against spraying the forests from aircraft after the points noted below had been presented to you. What would you do?

- For Spraying

  Unless the forests are sprayed, the wood needed to keep the mills going will be lost, the economy will suffer severely, and thousands of jobs will be lost.

  There is no conclusive evidence of human illness being associated with chemicals currently in use.

- Against Spraying

A number of people in the sprayed areas have become ill with unusual diseases and one or two of them have died. Admittedly, the connection with spraying has not been proven but people are afraid.

Points to consider

It is a difficult decision to make.

Perhaps a better control of the area to be sprayed can be achieved.

People whose health has suffered from the spraying could be compensated if the connection can be established.

More research aimed at alternative controls should be undertaken such as:

– the introduction of **diseases (pathogens)** that will spread through the budworm population (these bacteria and viruses must be selective, affecting only the desired species);

– the introduction of **parasites** that will feed on the budworm;

– spreading **sex attractants** that will disrupt normal mating behaviour.

Control in the long term through forest management is a possibility with a greater mix of species and varied age classes.

Perhaps, realistically, the best decision is to actively pursue the research above while spraying with the safest mixtures available. Remember, the Caterpillar slogan: There are no simple solutions: only intelligent choices.

7.3 DISEASE PROTECTION

Diseases may also be responsible for major wood losses. Further information on diseases is available from the Great Lakes Forest Research Centre in Sault Ste.Marie. There are many diseases of which only two are being considered here: Dutch elm disease and white pine blister rust.

a) Dutch Elm Disease

A high percentage of the elms in Ontario have been killed by this disease. It was first noticed in the Netherlands and Northern France. Early studies were done by the Dutch, hence the name.

The first case identified in North America was in Ohio in 1930. Since then it has spread all over the range of elm on this continent. Control procedures were not successful and most of the elm have died. However, young trees seem to be trying to make a come-back and treatments of city trees with fungicides has been successful.

Disease indicators

Early signs: drooping leaves/curling and shrivelling/browning

Mid-summer signs: yellowing/drooping leaves

Disease action and spread

Dutch elm disease is **caused by a fungus**, the spores of which are carried by **elm bark beetles**. In the elms, the fungus spreads through the water conducting systems.

The elm bark beetles breed in the bark of dead and dying elms. They fly to healthy trees to feed on the bark and take the spores with them. A limited spread of the disease may take place through root grafts where two elms are close together.

b) White Pine Blister Rust

This rust is a **fungus** that attacks white pine of all ages. It starts at a point in the bark and spreads until the trunk or branch is girdled and killed. As a result the tree is deformed and its growth greatly reduced.

Life cycle

The blister rust life cycle involves **alternate hosts**. The fungus spores move from the white pine to ribes bushes (currants and gooseberries) where different spores are produced that go on to infect the white pine. Then the cycle is repeated.

Control

Some control is possible but difficult.

- Gooseberry and currant bushes can be removed or killed but the spores can travel up to 2 km.

- Attempts are being made to develop strains of white pine that are resistant to the disease.

Appearance

Blister rust shows up as **reddish cankers** on the white pine bark. The branch or trunk beyond the infected part dies.

A somewhat similar effect is produced when **porcupines** girdle a tree while feeding. Again, the branch or trunk above the girdle dies with "bleeding" of sap and gum running down the tree.

UNIT 8
WILDLIFE MANAGEMENT

UNIT 8: WILDLIFE MANAGEMENT

OBJECTIVE

The objective of this unit is to have students recognize the broader values of forests. Wood is important but so are wildlife, water, watershed protection and recreation. Wildlife is selected as the topic to stress as its management is so closely related to forest management.

8.1 WILDLIFE

In the early days the fur trade opened up the country and expanded knowledge of its resources. Trapping continues to this day and is of economic importance. Fish and game are big items in our recreation and life style and have great importance in our economy. (A good project topic).

Wildlife in Ontario belongs to the crown and its management is the responsibility of the Ministry of Natural Resources.

Wildlife management resembles forest management in that its main goal tends to be the harvesting of a crop on a sustained yield basis. Wildlife management deals with many things such as population pyramids, food chains, food webs, carnivores and herbivores, the balance of nature, and so on. Many of these topics are dealt with in **biology courses** in secondary school programs. As with wilderness and multiple use forest management there are people who oppose the **cropping principle** for wildlife, preferring to let nature carry on undisturbed.

If a **harvest of wildlife** is not taken there is potential economic loss including a loss of jobs. The wildlife maintains its natural level through death with starvation often the cause. The other side of the argument is that hunting and trapping are cruel and should be restricted or abolished and that people should enjoy the wildlife as nature would have it.

Forests and wildlife are **interrelated** and coordinating their management may produce conflicts and problems. What is good for one is not necessarily good for the other. Game may feed on young tree seedlings. Logging may disrupt (or improve) game habitat. The public may want to hunt in a logging area.

Once again compromise and reasonable decisions are to be hoped for.

ACTIVITY

Wildlife management is a popular subject with many students, especially those that hunt and fish. It is often possible to have guests attend classes to discuss a variety of wildlife topics, and/or show films.

Topics might include the following:

- *Moose hunting regulations, and the reasons for them.*
- *The case for and against bounties on wolves with regard to deer management.*
- *The carrying capacity of a lake for a certain species of fish.*
- *Acid rain – the problems and solutions.*

APPENDICES

APPENDICES

1. Equipment requirements
2. Audio visual aids
3. Useful addresses

1. Suggested Equipment Requirements

When assessing equipment needs the class size and opportunities to share equipment need to be considered.

Basic items

clip boards	– at least one per two students
tree calipers	– steel or wood – at least one per three people
steel tape	– 30 metres with reel – one per three students
hypsometers	– Abneys, Suuntos, hagas or other – one per three students
increment boxes	– augers – one per six students
magnifying glasses	– 10x – one per two people
wedge prisms	– one per three students
stereoscopes	– Abrams pocket style – one per two students
compasses	– Silva ranger compasses – one per three students

Optional

bark thickness gauges
earth auger (for soil profiles)
display case
metal cupboard that can be locked for storage purposes

2. Audio Visual Aids

topographic maps	– available from governments
film strips	– topographic maps, map scale, map orientation, how trees grow, the Canadian Shield, etc.
films	– National Film Board, Ministry of Education, Ministry of Natural Resources, forest industries, etc.
Native Trees of Canada	– published by Canadian Forestry Service, Ottawa
Canadian Forestry: The View Beyond the Trees	– published by Canadian Forestry Service, Ottawa

SAMPLE FILM PROGRAM

Sept 21	Film	409 – Life in the Forest
	"	5441– Seed Germination
Oct 19	"	4294– Trees Grow Through The Years
		– Life in the Woodlot – OFA
Nov 16		– North of Superior – Ministry of Northern Affairs
Dec 7		– Foresters – OFA
Jan 4	"	430 – Forest Regions of Canada
Feb 8	"	532 – The Forest
		– Forests Forever – OFA
Feb 22	"	7200– Timber in Finland
	"	7607– Wood, Masterpiece of Creation
Mar 8		– Abitibi - Abitibi/Price
Apr 12		– Another Side of the Forest
May 2		– Fighting Forest Fires With Hand Tools – OFA

Note: Numbered films from Ministry of Education
OFA lends films only to members.
Some of these films are dated. Check for new releases.

3. Useful Addresses

a) Organizations

Association of Natural Resource Technicians of Ontario, 60 Inverlachy Blvd. Ste. 107, Thornhill, Ontario L3T 4T7

Canadian Forestry Association, 185 Somerset Street West, Ottawa, Ontario K2P 0J2

Canadian Institute of Forestry, 151 Slater Street, Ste. 815, Ottawa, Ontario K1P 5H3

Canadian Lumbermen's Association, 27 Goulburn Avenue, Ottawa, Ontario K1N 8C7

Canadian Paper Workers Union, 701 Evans Avenue, Ste. 709, Etobicoke, Ontario M9C 1A3

Canadian Pulp and Paper Association, Sun Life Building, 23rd Floor, 1155 Metcalfe Street, Montreal, Quebec H3B 2X9

Canadian Wood Council, 701-170 Laurier Avenue West, Ottawa, Ontario K1P 5V5

Christmas Tree Growers' Association of Ontario Inc., Box 94, Angus, Ontario L0M 1B0

International Woodworkers of America, 2088 Weston Road, Weston, Ontario M9N 1X4

Lumber and Sawmill Workers Union, Local 2693, Box 2384, Thunder Bay, Ontario P7B 5E9

Ontario Forest Industries Association, 130 Adelaide Street West, Ste. 1700, Toronto, Ontario M5H 3P5

Ontario Forestry Association, 150 Consumers Road, Ste. 209, Willowdale, Ontario M2J 1P9

Ontario Lumber Manufacturer's Association, 159 Bay Street, Ste. 414, Toronto, Ontario M5J 1J7

Ontario Maple Syrup Producers' Association, c/o General Delivery, Hillsdale, Ontario L0L 1B0

Ontario Professional Foresters' Association, 10,255 Yonge Street North, Ste. 202, Richmond Hill, Ontario L4L 3B5

b) Colleges and Universities

Algonquin College of Applied Arts and Technology, 315 Pembroke Street East, Pembroke, Ontario K8A 3K2

Lakehead University, School of Forestry, Thunder Bay, Ontario P7B 5E1

Sir Sandford Fleming College, Natural Resources Division, Box 8000, Lindsay, Ontario K9V 5S8

The Sault College of Applied Arts and Technology, 443 North Avenue, Box 60, Sault Ste. Marie, Ontario P6A 5L4

University of Toronto, Faculty of Forestry, 203 College Street, Toronto, Ontario M5S 1A1

c) Federal Government

Great Lakes Forest Research Centre, Canadian Forestry Service, Environment Canada, Box 490, Sault Ste. Marie, Ontario P6A 5M7

Petawawa National Forestry Institute, Canadian Forestry Service, Chalk River, Ontario K0J 1J0

Canadian Forestry Service, Environment Canada, Place Vincent Massey, Hull, Quebec K1A 1G5

Statistics Canada, Jean Talon Building, Tunney's Pasture, Ottawa, Ontario K1A 0T6

d) Ontario Ministry of Natural Resources – District Offices

ATIKOKAN, 108 Saturn Avenue, P0T 1C0 (807) 597-6971
ALGONQUIN PARK, Box 219, Whitney, K0J 2M0 (705) 637-2780
AYLMER, 353 Talbot Street West, N5H 2S8 (519) 773-9251
BANCROFT, Box 500, K0L 1C0 (613) 332-3940
BLIND RIVER, Box 190, P0R 1B0 (705) 356-2234
BRACEBRIDGE, Box 1138, P0B 1C0 (705) 645-5244
BROCKVILLE, Oxford Avenue, Box 605, K6V 5Y8 (613) 342-8524
CAMBRIDGE, R. R. 1, Beaverdale Road, N3C 2V3 (519) 658-9355
CARLETON PLACE, 10 Findlay Avenue, K7C 3Z6 (613) 257-5735
CHAPLEAU, 34 Birch Street, Box 460, P0M 1K0 (705) 864-1710
CHATHAM, Box 1168, N7M 5L8 (519) 354-7340
COCHRANE, 2 Third Avenue, Box 703, P0L 1C0 (705) 272-4365
CORNWALL, 113 Amelia Street, Box 1749, K6H 5V7 (613) 933-1774
DRYDEN, Box 3000, P8N 3B3 (807) 223-3341
ESPANOLA, Box 1340, P0P 1C0 (705) 869-1330
FORT FRANCES, 922 Scott Street, P9A 1J4 (807) 274-5337
GERALDTON, 208 Beamish Avenue, P0T 1M0 (807) 854-1030
GOGAMA, Box 129, P0M 1W0 (705) 894-2000
HEARST, 631 Front Street, Box 670, P0L 1N0 (705) 362-4346
IGNACE, Box 448, P0T 1T0 (807) 934-2233
KAPUSKASING, 6 Government Road, P5N 2W4 (705) 335-6191
KIRKLAND LAKE, Box 129, Swastika, P0K 1T0 (705) 624-3222
KENORA, Box 5080, P9N 3X5 (807) 468-9841
LINDSAY, 322 Kent Street West, K9V 2Z9 (705) 324-6121
MAPLE, L0J 1E0 (416) 832-2761
MIDHURST, L0L 1X0 (705) 728-2900
MINDEN, K0M 2K0 (705) 286-1521
MOOSONEE, Box 190, P0L 1Y0 (705) 336-2987
NAPANEE, 1 Richmond Boulevard, K7R 3S3 (613) 354-2173
NIAGARA, Box 1070, Fonthill, L0S 1E0 (416) 892-2656
NIPIGON, Box 970, P0T 2J0 (807) 887-2120
NORTH BAY, 222 McIntyre Street West, P1B 8K7 (705) 474-5550
OWEN SOUND, 611 9th Avenue East, N4K 3E5 (519) 376-3860
PARRY SOUND, 4 Miller Street, P2A 1S8 (705) 746-4201
PEMBROKE, Riverside Drive, K8A 6X4 (613) 732-3661
RED LAKE, Box 5003, P0V 2M0 (807) 727-2531
SAULT STE. MARIE, 69 Church Street, P6A 5L5 (705) 949-1231
SIMCOE, 645 Norfolk Street North, N3Y 3R2 (519) 426-7650
SIOUX LOOKOUT, Box 309, P0V 2T9 (807) 737-1140
SUDBURY, Box 3500, Stn. A, P3A 5S3 (705) 522-7823
TEMAGAMI, Box 38, P0H 2H0 (705) 569-3622
TERRACE BAY, Box 280, P0T 2W0 (807) 825-3205
THUNDER BAY, 435 James Street South, P7C 5G6 (807) 475-1421
TIMMINS, 896 Riverside Drive, P4N 3W2 (705) 267-7951
TWEED, 265 Metcalfe Street, K0K 3J0 (613) 478-2330
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